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Shipboard oil-water separators used for the treatment and disposal of ship's bilge-water

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SHIPBOARD OIL-WATER SEPARATORS USED

FOR THE TREATMENT AND DISPOSAL

OF SHIP'S BILGE-WATER

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By

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LIST OF ABBREVIATIONS

AO....................................Auxiliary Oiler
BOWTS.................................Bilge and Oily Wastewater Treatment System
CFR...................................Code of Federal Regulations
CG....................................Guided Missile Cruiser
CNO...................................Chief of Naval Operations
COD...................................Chemical Oxygen Demand
COMNAVBASE ....Commander Naval Base
COMNAVBASEPEARLINST...Commander Naval Base Pearl Harbor Instruction
CWA...................................Clean Water Act
DAF...................................Dissolved Air Floatation
DD....................................Destroyer
DDG...................................Guided Missile Destroyer
EPA...................................Environmental Protection Agency
FFG...................................Guided Missile Fast Frigate
GENADMIN..............................General Administrative (message)
gpd...................................Gallons Per Day
mg/l..................................Milligrams Per Liter
NFESC.................................Naval Facilities Engineering Center
NPDES.................................National Pollution Discharge Elimination System
OCM...................................Oil Content Monitor
OWS...................................Oil Water Separator
OWWO..................................Oily Waste Waste Oil
ppm...................................Parts Per Million
PMS...................................Preventive Maintenance Schedule
PWC Pearl Harbor......................Navy Public Works Center Pearl Harbor, Hawaii
RCRA..................................Resource Conservation Recovery Act
SGIW..................................Ship Generated Industrial Waste

LIST OF ABBREVIATIONS (continued)

SWOB	Ship Waste Off-load Barge
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids
U.S.	United States
U.S.C.A.	United States Code Annotated
VTC	Vertical Tube Coalescing
YON	Yard Oil Navy

CHAPTER 1

INTRODUCTION

1.1 Background

The Federal Government has established environmental regulations for water quality control. These standards preserve the environment and control the physical and chemical characteristics and quantities of discharges into water bodies. Primary among these regulations are the Clean Water Act, its amendments and 40 CFR 30 through 35, 60, 122, 123, 124, 125, 129, 130, 131, 133, 141, 144 and 501, which deal with numerous issues related to discharges to water, groundwater, air, and land.

The large extent of U.S. Navy operations in and on these waterways has had an impact on the water quality. However, the Navy policy has been, and still is, to perform operations in manners that meet or exceed the established federal, state, and local environmental laws and regulations. One area of particular concern to the Navy is the discharge and disposal of ships' bilge-water while in port. Bilge-water is the accumulation of liquids and oils that are generated anytime a ships' engineering spaces are in operation. Seawater leaking into the hull as well as normal shipboard housekeeping functions also contribute to the bilge-water. The practice has been for ships to discharge of this bilge-water to oil disposal rafts (donuts) for proper disposal at a later time. However, water quality boards have questioned the environmental soundness of this practice.

In February 1995, the Navy stopped using donuts at Naval Station Pearl Harbor. Commander Naval Base (COMNAVBASE) Pearl Harbor

issued a general administrative (GENADMIN) message on 22 February 1995 that was based upon Chief of Naval Operations (CNO) Navgram 451 (8 April 1991). The GENADMIN message contained policy guidance which authorized ships with oil-water separators (OWS) and oil content monitors (OCM) to discharge bilge-water directly overboard if the discharged water contained less than 15-parts per million (ppm) oil. (An oil content of 15-ppm or greater will produce an oily sheen on the water surface.) If ships were unable to meet this oil content limit, or were not equipped with oil-water separators and oil content monitors, they would then discharge their bilge-water into designated tank trucks. These trucks would then properly dispose of the bilge-water.

1.2 Bilge-water Studies at Pearl Harbor

A 1992 study by Scott Bernotas examined the use of donuts for bilge-water disposal (Bernotas, 1992). Bernotas evaluated alternative disposal methods that could be implemented quickly in order to prevent further degradation of the harbor waters, as well as alternatives that would be useful in the future. Bernotas referenced a study from Native American Consultants, Inc. (Native American Consultants, Inc., 1992) which found that bilge-water is composed of a mixture of seawater and fresh water (95 to 99%), with oil and other contaminants accounting for the remaining portion (Bernotas, 1992, p. 2). He further examined Federal Standards and determined that bilge-water should be considered a non-hazardous waste under 40 CFR 261.3.

The Navy Public Works Center, Pearl Harbor, Hawaii, (PWC Pearl Harbor) examined other means of disposing of bilge-water (PWC Bilge-Water Management Interim Report, 1993). PWC Pearl Harbor concluded that bilge-water can be pretreated, then discharged into the sanitary sewer system for disposal. Bilge-water pre-treatment in a Vertical Tube Coalescing/Dissolved Air Floatation (VTC/DAF) system would help keep the discharged contaminants under the wastewater discharge limits prescribed in the COMNAVBASE instruction 11345.2C (COMNAVBASE-PEARLINST 11345.2C). This instruction set the limits for discharges into the Navy sanitary sewer system based upon four major factors. These included Federal pretreatment standards for waste discharges, the concentrations of passed-through contaminants which could cause a facility to violate its National Pollution Discharge Elimination System (NPDES) permit, the concentrations that would inhibit or interfere with the treatment plant sludge handling and disposal operations, and the concentrations that would affect the treatment plants effluent causing toxic effects on the receiving water's biota (CONMAVBASEPEARLINST 11345.2C, 1989, p. 2).

A 1994 study by Elvin R. Nunes evaluated the effectiveness of the VTC/DAF in pre-treating bilge-water before discharging it into the sanitary sewer system (Nunes, 1994). Through controlled studies, Nunes examined and compared the characteristics of 25 constituents found in the bilge-water on both the influent and the effluent sides of a VTC/DAF treatment system (Nunes, 1994, p. 3). He compared the influent characteristics of his bilge-water samples with those from the Native American Consultants, Inc.

bilge-water characterization study (Native American Consultants, Inc., 1992). He also compared the treated effluent with the COMNAVBASE-PEARLINST 11345.2C discharge limits to determine the effectiveness of the VTC/DAF in reducing the contaminants below given levels.

The results of the Nunes study indicated that although not all of the contaminants were totally removed from the bilge-water with this pretreatment method, it was able to substantially remove many of the contaminants. However, based upon the COMNAVBASE discharge limits, the use of the VTC/DAF as a stand-alone means of treating bilge-water prior to discharge into the Ft. Kamehameha sewer system was not successful (Nunes, 1994, p. 155). This determination was based upon the inability of the pre-treatment to remove the chlorides to within acceptable limits. Nunes also had concerns with the air emissions and the sludge generated in the VTC/DAF process. The air emissions had potential to exceed the standards for the Reid vapor pressure as set by the Hawaii Department of Health in the Hawaii Administrative Rules, Title 11, Chapter 59. In certain cases, the sludge generated by the pre-treatment was a hazardous material that required proper handling and disposal.

Nunes also compared ship-generated industrial waste (SGIW) characteristics to bilge-water characteristics. SGIW is that waste stream which is generated primarily from the cleaning operations performed on ships during routine repairs and maintenance. These operations include tank cleaning, boiler cleaning, distribution line flushing, etc. Most of this water is collected where it is generated, although some of it migrates down

into the bilges of the ship (Nunes, 1994, p. 35). Nunes found that the SGIW characteristics were fairly consistent with the bilge-water characteristics.

1.3 Thesis Statement

The Navy based its decision to discharge the effluent directly into the harbor upon previous bilge-water studies and the CNO direction. However, neither COMNAVBASE nor PWC Pearl Harbor have tested the bilge-water effluent directly from the shipboard OWS. The purpose of this study was to examine the bilge-water that is treated in the shipboard OWS and then discharged directly into the harbor. The overall goal of the study was to determine the bilge-water contaminant levels in the OWS influent and effluent, and then, based upon this information, determine the effectiveness of the OWS in removing these contaminants.

Samples of bilge-water were collected from four Navy ships of different classes and of varying ages. These samples were taken from the various ships OWS influent and the effluent streams, then tested for 21 given contaminants. The selection of the 21 examined constituents was based in part upon the wastewater discharge limitations as found in COMNAVBASEPEARLINST 11345.2C. The effectiveness of the OWS in meeting these limitations was reviewed.

The influent values from this study and the Nunes study were compared to the influent values found in the Native American Consultants, Inc. bilge-water characterization study (Native American Consultants, Inc., 1992). This was to show that the bilge-water used in the two later

studies were a representative sample of bilge-water from throughout the Navy as determined by the Native American Consultants, Inc. study.

Additionally, both the influent and effluent contaminant quantities from this study were compared to the bilge-water contaminant quantities found during the Nunes study in which the VTC/DAF treatment was used. Twenty one of the 25 contaminants examined in the Nunes study were examined in this study. By testing for the same influent and effluent contaminants, the data from the two studies was able to be directly correlated in order to compare the two different treatment systems.

Although Navy ships have the authority from the COMNAVBASE GENADMIN message of 22 February 1995 to discharge bilge-water directly into the harbor, there is concern over the contaminants, and quantities of such, that are being put into the Pearl Harbor waters. The quantifying of the contaminants being discharged by the OWS's has not previously been performed at Pearl Harbor. The results of this test can provide the Navy with very basic information on the amounts of the tested contaminants that are being discharged directly into the harbor when OWS's are used in port.

CHAPTER 2

APPLICABLE REGULATIONS

2.1 Overview

The Navy is dedicated to operating its ships and shore facilities in a manner that is harmonious with the environment. The "Federal Compliance with Pollution Control Standards", Executive Order 12088, mandates that Federal facilities control and monitor environmental pollution in compliance with Federal environmental regulations (Bilge-water Management Interim Report, 1993, p. 2-1). In order to maintain compliance, any facilities or property used by the Navy must be designed, operated and maintained in accordance with all applicable pollution control standards.

Maintaining compliance has raised a number of serious questions. The questions specifically involve permitting which is required under the NPDES Program found in 40 CFR 122. The issue of whether shipboard discharges of the OWS effluent into harbor waters require NPDES permits was voiced to the Navy on several occasions by different state water quality boards. Currently, the Navy interprets the Federal NPDES permitting regulations and requirements to be non-applicable to naval vessels. This interpretation is based upon an exemption found in 40 CFR 122.3, which states that discharges incidental to a ships normal operations do not require permitting.

Several Federal regulations apply directly to the discharge of bilge-water into navigable waters. The principle regulations are listed below.

- EPA Regulations for Identifying Hazardous Waste, 40 CFR 261
- Coast Guard Oil or Hazardous Material Pollution Prevention Regulation for Vessels, 33 CFR 155
- Clean Water Act, (Federal Water Pollution Control Act), 33 U.S.C.A. §§ 1251 to 1387
- EPA National Pollutant Discharge Elimination System Permit Regulations, 40 CFR 122
- EPA Regulation on Discharge of Oils, 40 CFR 110

The applicability of each of these laws to the generation and discharge of bilge-water and OWS effluent follows.

2.2 EPA Regulations for Identifying Hazardous Waste, 40 CFR 261 - Hazardous Waste or Solid Waste Determination

The Resource Conservation and Recovery Act (RCRA) addresses hazardous waste and solid waste management and disposal practices. It defines a full regulatory program aimed at the generation, transportation and disposal of such wastes, as well as the handling of emergencies and cleanup of old inactive sites. The purpose of RCRA is to provide a system for the tracking and record preservation of hazardous waste, to ensure proper disposal of the waste and to provide an enforcement mechanism with which to ensure compliance. EPA Regulations for Identifying Hazardous Waste, 40 CFR 261, identify and define those wastes which are subject to RCRA requirements.

It is important to ascertain if bilge-water is a hazardous waste in order to ensure its proper disposal. The EPA regulations must be consulted in order to make this determination of hazardous material or solid waste.

Five questions found in 40 CFR 261.3 must be answered to make this determination.

- Is the waste a solid waste?
- If the waste is a solid waste, is it excluded from regulation as a hazardous waste under 40 CFR 261.4 (b)?
- Does the waste exhibit any of the characteristics listed in Subpart C of 40 CFR 261?
- Is the waste listed as a hazardous waste in Subpart D of 40 CFR 261?
- If the waste is a mixture of a solid waste and a hazardous waste, is the hazardous waste listed in Subpart D of 40 CFR 261?

Using these 5 questions from the regulations, Bernotas (1992) established that bilge-water is considered a solid waste although it is not considered a hazardous waste (Bernotas, 1992, p.19).

2.3 Coast Guard Oil or Hazardous Material Pollution Prevention Regulations for Vessels, 33 CFR 155

The Coast Guard Oil or Hazardous Material Pollution Prevention Regulations for Vessels, 33 CFR 155, covers the containment requirements for bilge-water slops, fuel oil tank ballast water discharges, and oily water releases. It also indicates that U.S. inspected, U.S. uninspected, and foreign ships must have oil-water separating equipment, bilge alarms, and bilge monitors which have been approved under 46 CFR 162.050. Oil-water separating equipment capable of attaining 15 ppm oil-water separation is generally required, although in some cases this may be as high as 100 ppm.

The Navy, however, is exempt from compliance of this law under 33 CFR 155.100 (b), which specifically states that "this part does not apply to: (1) A warship, naval auxiliary, or other ship owned and operated by a country when engaged in non-commercial service. . . ." Despite the exemption, the Navy is outfitting all ships with oil-water separators and oil content monitors. When the retrofit is complete, the Navy will show good faith towards environmental concerns by complying with the 33 CFR 155 monitoring equipment requirements.

2.4 Clean Water Act (Federal Water Pollution Control Act), 33 U.S.C.A. §§ 1251 to 1387

The primary objective of the Clean Water Act (CWA) is to " . . . restore and maintain the chemical, physical and biological integrity of the Nation's waters" (33 U.S.C.A. § 1251). The objective is accompanied by statutory goals to regulate, and eventually eliminate, the discharge of pollutants into navigable waters of the United States. The CWA consists of two major parts: regulatory provisions that impose progressively more stringent requirements on industries and cities to abate pollution and meet the statutory goal of zero discharge of pollutants; and provisions that authorize Federal financial assistance for municipal wastewater treatment construction. Both parts are supported by research activities, plus permit and penalty provisions for enforcement. Programs at the Federal level are administered by the EPA; state and local governments have major responsibilities to implement those programs (Copeland CRS, 1994, p. 1).

The primary goal within the CWA that relates to bilge-water management involves the elimination of toxic pollutants discharged into navigable waters. The in-port discharging of effluents incidental to ships operations is one of the more frequently raised shipboard environmental issues. The discharge of oil and oily wastes from ships is regulated by the EPA Regulations on Discharge of Oil, 40 CFR 110. The permitting program that regulates discharges into navigable waters from "point sources" is the National Pollution Discharge Elimination System, which is defined in the EPA regulations 40 CFR 122.

2.5 EPA National Pollutant Discharge Elimination System (NPDES) Permit Regulations, 40 CFR 122

The EPA National Pollutant Discharge Elimination System (NPDES) Permit Regulations, 40 CFR 122, require permits for the discharge of "pollutants" from any "point source" into "waters of the United States". This regulation, the Clean Water Act (33 U.S.C.A. §1251, et. seq.), and the issue of whether Navy ships can be regulated under this Program has been questioned on numerous occasions by different State Water Quality Boards.

The water quality boards contend that Navy ships are "point sources" discharging into navigable waters. The Navy contends that the discharges are exempt from permitting under 40 CFR 122.3, which states that ". . . the following discharges do not require NPDES permits: (a) any discharge of sewage from vessels, effluent from properly functioning marine engines, laundry, shower, and galley sinks, or any other discharge incidental to the normal operation of a vessel."

Because bilge-water is generated when a ship's engineering spaces are in operation and from normal shipboard housekeeping activities, it will accumulate both while the ship is in port and while it is underway. It must be discharged to prevent the bilges from becoming full, thus causing both operation and equipment problems. This is all incidental to the normal operations of the ship. Based upon this, Navy legal offices have made the determination that military ships are exempted from the permitting requirements.

2.6 EPA Regulations on the Discharge of Oil, 40 CFR 110

The EPA Regulations on Discharge of Oil, 40 CFR 110, apply to the discharge of oil into waters as prohibited by the Clean Water Act (CWA), 33 U.S.C.A. §1321 (b)(3). It prohibits discharges of such quantities that may be harmful to the public health or welfare of the United States, violate applicable water quality standards, or cause a film or sheen upon, or discoloration of, the water surfaces. 40 CFR 110.7 specifically states that "For purposes of section 311 (b) of the Act, discharges of oil from a properly functioning vessel engine are not deemed to be harmful, but discharges of such oil accumulated in a vessel's bilges shall not be so exempt."

The definition of a vessel in this regulation reads " . . . every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water other than a public vessel. . . ." The definition of public vessel, similarly, reads " . . . a vessel owned or bareboat chartered and operated by the United States, or by a State

or political subdivision thereof, . . . except when such vessel is engaged in commerce."

Based upon these definitions and legal interpretations, military ships could be considered to be public vessels, being owned and operated by the United States or a subdivision thereof. 40 CFR 110.7 specifically states "vessel" rather than "public vessel". Taken literally, as only vessels other than public vessels, this would exempt military ships from the prohibition of discharging oil accumulated in the bilges into navigable waters, as found in 40 CFR 110.7.

The Navy does not authorize ships without oil-water separators and oil content monitors to discharge bilge-water into harbors or within a 25-nautical mile limit of U.S. territory. In order to comply with this Navy requirement, most ships are being retrofitted with oil-water separators which remove oil from the bilge-water to levels of less than 15-ppm. The oil-water separator effluent is pumped overboard, while the oil is stored in waste oil holding tanks for later removal and disposal. The use of the oil-water separators would therefore act to further support the regulation requirements as a viable alternative to military exemption.

2.7 Summary

There are currently a number of Federal Regulations that pertain to the discharge of bilge-water into U.S. waters. Military ships are exempt from the above discussed regulations based upon either direct wording within regulation clauses or by direct interpretations of the definitions.

Despite these exemptions, the Navy has been proactive in taking steps to come into compliance with these regulations. All Navy ships are planned to be, or have already been, retrofitted with oil-water separators and oil content monitors.

The regulation that is of primary concern with respect to the bilge-water discharges is the NPDES Permitting Program. This regulation requires discharge limiting permits from all point sources. Navy legal personnel have made the determination that the ships are exempt from the permitting requirement based upon the 40 CFR 122.3 clause which exempts discharges that are incidental by-products of a ship's normal operations. Bilge-water is produced as an incidental by-product of a ship's normal operation, and is therefore exempted from permitting under the NPDES program.

CHAPTER 3

BILGE-WATER TREATMENT AND DISPOSAL METHODS

A ship's bilge is defined as the interior region of the ship's hull that exists between the lowest point and the bottom of the vertical sides of the ship. The majority of the engineering compartments within the ship have drains that allow any spilled, leaked or washed liquids to be collected in the bilge area. Bilge-water is defined as all of the drained liquid that accumulates within the confines of this area and generally consists of a combination of seawater, solvents, fuel, hydraulic and lubricating oils and liquids from the ships cargo. Bilge-water characterization studies performed by Native American Consultants, Inc. in October 1992 analyzed the constituents of the bilge-water taken from 46 Navy ships, finding that it is primarily comprised of 95 - 99% seawater; however, oil and trace amounts of various metals were also found. The oil was either dissolved, dispersed, emulsified, or free oil (Bernotas, 1992, p.2). The more common sources of bilge-water are listed in Table 3.1 (Nunes, 1994, p. 11).

Bilge-water is generated both at sea and in port. It is allowed to accumulate in ships' bilges until they have become full. Bilges are emptied regularly after they are either full or half full. Studies and published reports have indicated that on the average, Navy ships generate between approximately 3700-gallons per day (gpd) of bilge-water for most surface combatants, to 50,600-gpd for aircraft carriers and oil replenishing ships (Bernotas, 1992, p. 22). However, according to ship's personnel who

Table 3.1 TYPICAL BILGE-WATER SOURCES

Spaces/Compartments	Machinery/Components
Engine room	Lube Oil Pumps
Main Engine Room	Fuel Oil Pumps
Auxiliary Engine Room	Fire Pumps
Fireroom	Condensers
Main Machinery	Fuel Oil Manifolds
Generator Room	Forced Draft Blowers
Pump Room	Boilers
Port and Starboard Shaft Alley	Cooling Water Pumps
Shaft Alley Center	Feed Pumps
Forward Emergency Diesel	Reduction Gears
Steering Space	Evaporators
Air Conditioning	Compressors
Turntable Pits	Ballast Tanks
Cargo Elevator Room	
Elevator Trunk	
Sonar Dome and Equipment Room	
Sonar Eductor Room	

operate the OWS equipment, and to bilge pumping records from the PWC Pearl Harbor tank trucks, these figures are on the high side. Average bilge-water amounts generated by surface combatants are closer to between 50-and 100-gpd while in port, and 1000-gpd while underway.

3.1 Donuts

Until recently, Pearl Harbor utilized floating Oil Disposal Rafts (donuts) and Ships Waste Offload Barges (SWOBs) to contain the discharges of bilge-water and other liquid wastes from ships. This was believed to be

an environmentally acceptable method of handling the wastes. The liquid wastes that were not disposed of through the use of the donuts were pumped into tank trucks on shore and disposed of via other methods.

Donuts in principle, are a very basic gravity oil-water separator. When bilge-water is discharged into the donut at a controlled rate, it mixes with the harbor water already in the donut. This water level is maintained at approximately six feet below the top of the unit. The oil portion of the bilge-water separates from the rest of the discharged liquid and rises to the top of the water contained within the donut. The oil collects on top of the water and equates to a maximum capacity of approximately 9,000-gallons of oil. As new bilge-water is added to the donut, the liquid from which the oil has already separated is forced out of the donut through either riser pipes or holes in the bottom of the donut. The donuts used at Pearl Harbor all had closed bottoms and used riser pipes for disposal overboard. The theory behind the use of the donuts is that the time retention and the volume of the liquid within the donut (approximately 26,000-gallons) will provide a substantial dilution of the bilge-water. The liquid that is displaced will then meet the Federal requirement of having less than 15-ppm oil content, and will not produce an oily sheen on the water surface.

Concern has risen within the Navy over the use of donuts. In the past, the EPA and the various states have not monitored the use of donuts, and the donuts have not required permits under the NPDES program. However, some state water quality boards have recently begun to consider bilge-water to be a hazardous waste. Because there is the possibility that oil and the remaining bilge-water liquids are easily able to escape from the

donuts and get into the surrounding harbor waters, the state boards have begun to scrutinize the use and ability of donuts to consistently meet water quality standards. In response to this scrutiny from the states, the Navy has studied and evaluated the continued use of the donuts. In a Chief of Naval Operations (CNO) Navgram message released 8 April 1991, the CNO stated that the Navy would adopt a policy to eliminate the use of donuts as soon as possible. In the Final Report of the CNO Environmental Quality Management Board Ship-Shore Bilge Waste Management Task Action Team, dated October 1994, the final elimination date for donuts was set at the end of 1996.

As a result of these requirements from the CNO, the COMNAVBASE Pearl Harbor Oily Waste Waste Oil (OWWO) Task Force studied options for the collection and treatment of OWWO, which includes bilge-water. As a result of the study, a COMNAVBASE message released on 22 February 1995 ceased further use of donuts in Pearl Harbor, effective immediately upon message release. The message, however, did list available options and means for ships to dispose of bilge-water.

3.2 Vertical Tube Coalescing and Dissolved Air Floatation System

The VTC/DAF system was being tested as part of a PWC Pearl Harbor bilge-water treatment pilot program. Under this program, all bilge-water would be discharged from the ships into this treatment system. It would then be pretreated and discharged into the sanitary sewer lines leading to the Fort Kamehameha Wastewater Treatment Plant.

The VTC/DAF system is a full flow pressurized system composed of two primary components: the VTC and the DAF. The VTC consists of a series of vertical, perforated polypropylene oleophilic tubes. As the bilge-water passes through these tubes, the free oil droplets are attracted to the polypropylene oleophilic tubes, where they amass into larger droplets. When enough droplets have amassed, the oil floats to the surface of the VTC unit. A rotary pipe skimmer on the fluid surface collects the free floating oil and routes it to a separate oil collection tank.

The bilge-water passes from the VTC into a surge tank. The surge tank ensures that a constant pressure head is applied to the liquid. Iron, lime, hydrogen peroxide and a polymer are added to the bilge-water at this point. These chemicals aid in the removal of the emulsified oils and other contaminants.

The chemically treated bilge-water is then routed to the retention tank via a transfer pump. In the retention tank, air is forced into the bilge-water under approximately 42-psi pressure, and is allowed time to totally dissolve and mix into the solution. Upon leaving the retention tank, the bilge-water solution is reintroduced to atmospheric pressure in the DAF tank. This change in pressure causes the dissolved air to rise to the top of the bilge-water solution in the form of tiny bubbles. The dissolved air will tend to form these bubbles on solid particles; in this case the solid particles are the emulsified oil and other contaminants. These particles then rise to the surface with the air bubbles, creating a sludge on the liquid surface. This sludge is removed with floating scrapers.

The remaining bilge-water passes through a series of additional baffles before reaching a distribution trough. At this point, enough oil and other contaminants have been removed from the bilge-water to allow it to be discharged into the Fort Kamehameha Wastewater Treatment Plant system.

3.3 Oil-Water Separator/Induced Air Floatation System

The Naval Facilities Engineering Center (NFESC) developed a bilge and oily wastewater treatment system (BOWTS) for installation and use at Naval Station Pearl Harbor. PWC Pearl Harbor has begun a Special Project construction project to procure and build the BOWTS so that the treated bilge-water effluent can be discharged into the Fort Kamehameha Wastewater Treatment Plant system. Unlike the system used in the pilot program mentioned in Section 3.2, this system will consist of an oil-water separator and an induced-air floatation (OWS/IAF) system.

The OWS operates on the same principle of gravity separation as will be explained in Section 3.4. The particular OWS system specified for this system will be a slant-ribbed coalescing separator. The filters are made of a corrugated plastic media with high oleophilic characteristics. The bilge-water passes from the OWS into the induced air floatation (IAF) system.

This IAF system is contained within a coded pressure vessel. Air bubbles are formed and dispersed by a specially designed eductor-disperser mechanism before being uniformly introduced into the bilge-water. These bubbles coalesce with the oil and contaminants found in the bilge-water and

rise to the surface of the tank, creating a froth. When the liquid level in the tank reaches a certain level, the froth will spill into skim troughs for removal. As with the DAF system, chemical additives are used to facilitate the removal of the contaminants. The chemicals are added based upon laboratory test results that indicate which particular contaminants are present in excessive quantities.

3.4 Oil-Water Separators

The February 1995 COMNAVBASE message authorized surface ships with installed shipboard OWS's and functioning oil content monitors (OCM) to discharge the liquid fraction of processed bilge-water directly overboard into the harbor, provided that the oil content does not exceed 15-ppm and does not create an oily sheen on the water surface. No other effluent parameter limits were specified by COMNAVBASE. Monitoring of the effluent, except for oil content via the OCM, was not required of the ships.

There are several different models of OWS's used aboard Navy ships. All of the models however, operate on the same principle of gravity based oil-water separation and filter coalescence. Typical models found onboard the ships homeported in Pearl Harbor included the OPB-10NP oil-water separator system which was manufactured by Fram Industrial Filter Corporation, the VGS-10 oil-water separator system manufactured by SAREN, or the Parmatic Filter Corporation Model 690231. The Parmatic Filter Corporation Model is basically identical to the Fram Model, and uses

the Fram stacked filter plates. Figures 3.1 through 3.4 show the Fram OPB-10NP model and its filter plate assembly. Figures 3.5 through 3.7 show the SAREN VGS-10 model and its filter plate assembly.

The OWS's were designed to meet specific Navy requirements which included being able to sustain a variety of different operating environments and influent characteristics. All of the OWS models were designed to operate both automatically and manually, to process oily water at a rate of 10-gallons per minute, and to function in either continuous or intermittent operation. Standard system capacities were designed at 55-gallons. Additional Navy requirements included demonstrating that the equipment was capable of a 500-hour mean time between failures at a 90% level of confidence, and that 95% of the repair times took less than 3-hours. Failure was defined as any malfunction which shut down the system or allowed oil contents of greater than 15-ppm to be discharged.

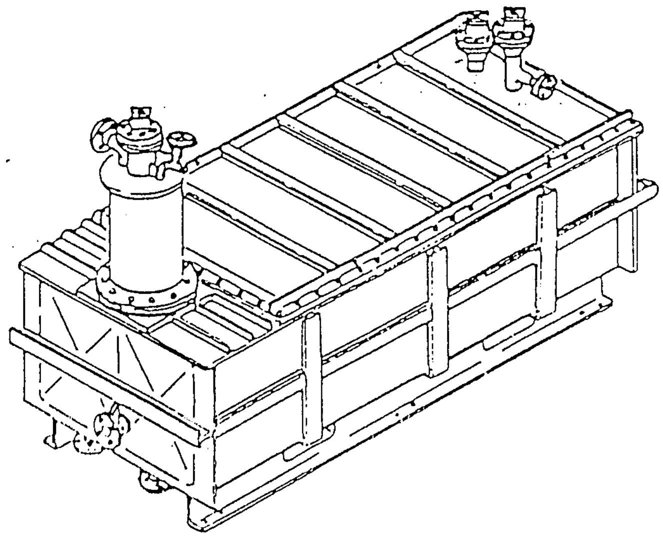

Figure 3.1 *FRAM* OIL-WATER SEPARATOR

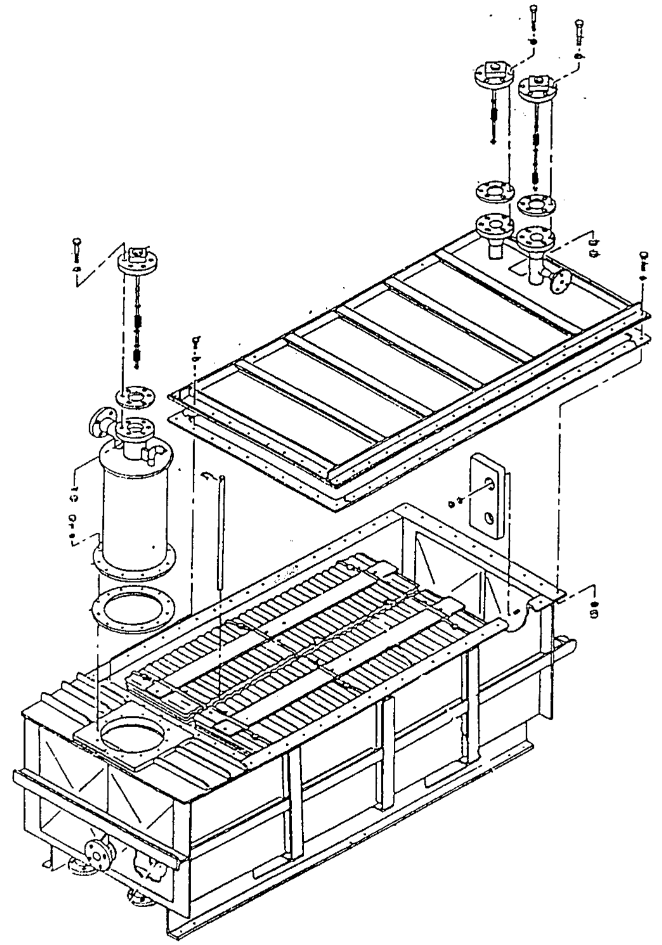

Figure 3.2 *FRAM* OIL WATER SEPARATOR ASSEMBLY

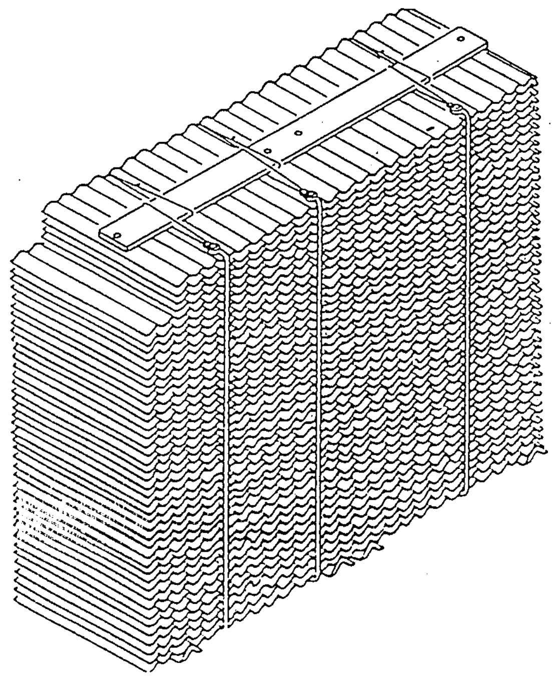

Figure 3.3 *FRAM* COALESCING PLATES

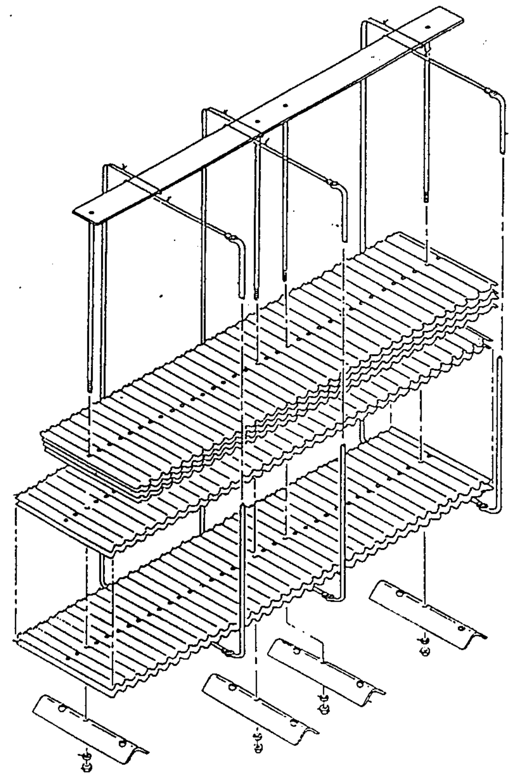

Figure 3.4 *FRAM* COALESCING PLATE ASSEMBLY

Component No.	Component Description
1	Solenoid Operated Water Discharge Valve
2	Sample Valve - Third Stage Separator Outlet
3	Water Discharge Line
4	Oil Discharge Valve - Third Stage Separator
5	Cover - Third Stage Separator
6	Automatic Air Eliminator Valve - Third Stage Separator
7	Cam Bar - Third Stage Separator
8	Sight Glass - Third Stage Separator
9	Cover - Second Stage Separator
10	Automatic Air Eliminator Valve - Second Stage Separator
11	Cam Bar - Second Stage Separator
12	Oil-Level Sensor - Second Stage Separator
13	Sight Glass - Second Stage Separator
14	Sight Glass Shutoff Valve - First Stage Separator
15	Sight Glass - First Stage Separator
16	Differential Pressure Gauge - Third Stage Separator
17	Cover - Separator
18	Automatic Air Eliminator Valve - First Stage Separator
19	Cover Clamp - First Stage Separator
20	Differential Pressure Gauge - Second Stage Separator
21	Pressure Gauge - First Stage Separator Outlet
22	Oil-Level Sensor - First Stage Separator
23	Sample Valve - First Stage Separator Inlet
24	Supply Pump
25	Electric Motor
26	Junction Box
27	Belt Guard
28	First Stage Separator
29	Anode - Separator
30	Vessel Drain Valve - First Stage Separator
31	Solenoid Operated Oil Discharge Valve
32	Pressure Relief Discharge Line
33	Sample Valve - First Stage Separator Outlet
34	Oil Discharge Line
35	Sight Glass Shutoff Valve - Second Stage Separator
36	Second Stage Separator
37	Solenoid Operated Oil Discharge Valve - Second Stage Separator
38	Vessel Drain Valve - Second Stage Separator
39	Sight Glass Shutoff Valve - Third Stage Separator
40	Third Stage Separator
41	Vessel Drain Valve - Third Stage Separator
42	Skid

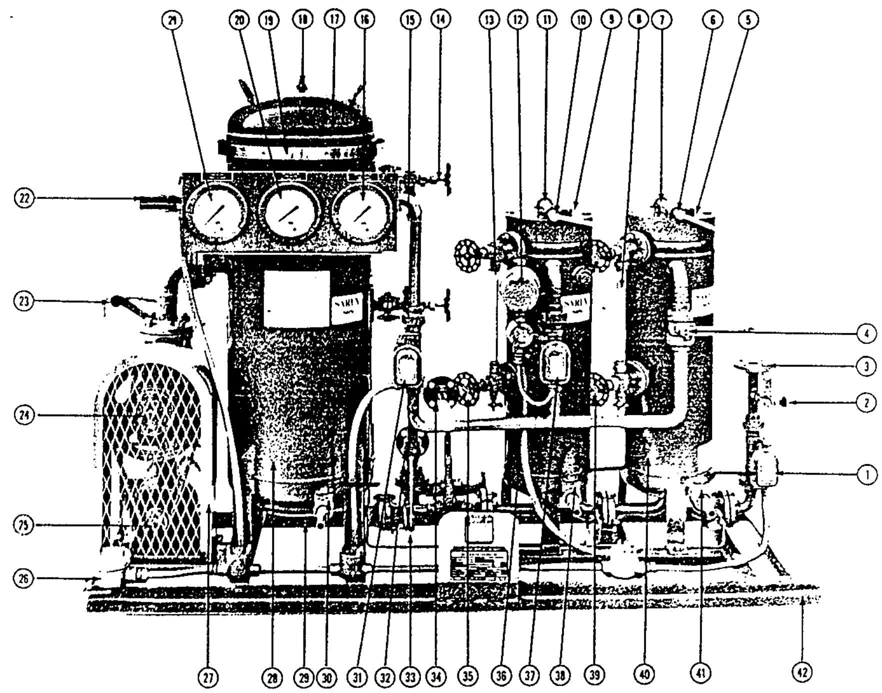

Figure 3.5 *SAREN* OIL-WATER SEPARATOR SYSTEM

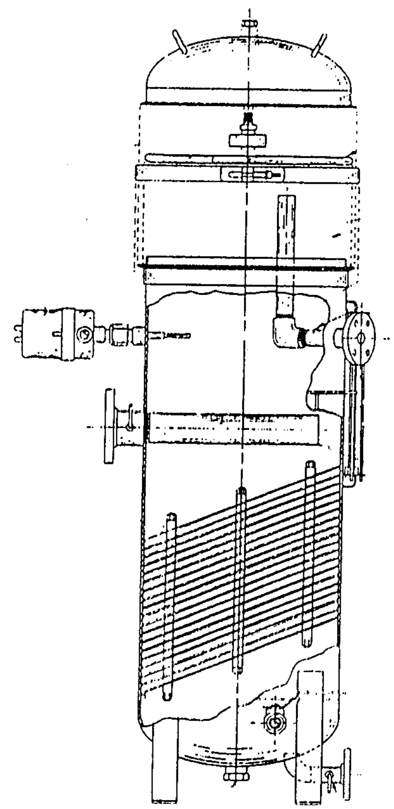

Figure 3.6 *SAREN* OIL-WATER SEPARATOR TANK (STAGE 1)

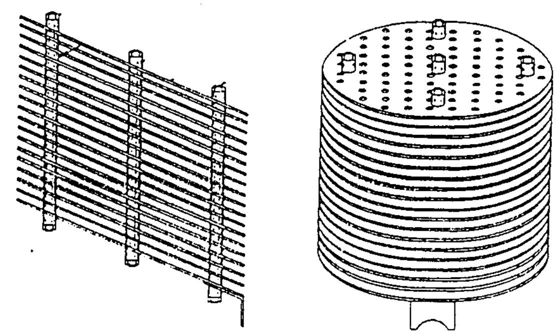

Figure 3.7 *SAREN* COALESCING PLATE ASSEMBLY

3.4.1 OWS Operation

The purpose of the oily waste water drainage systems aboard Navy ships is to intercept the discharges from equipment servicing petroleum products and to separate the oils from the water. The oils can then be retained for proper disposal while the water effluent can be discharged overboard. The primary components of the system include the oily waste drain tanks (bilge tanks), the bilge pumps, the oily waste water holding tanks, the oil-water separators, and the waste oil retention tank. All of the shipboard OWS systems operate along similar principles.

Water from the bilges is pumped to the oily waste water holding tanks. It then flows through a strainer that removes large particles of debris and sludge before entering the OWS, which has been primed with either fresh water or seawater. The bilge-water enters the OWS horizontally at the bottom of the tank and flows upward through a series of stacked plates. The plates are made of a polypropylene material with high oleophilic properties and may be either corrugated as in the Fram system or smooth as in the SAREN model. The plates are stacked horizontally with a 1/4 inch separation, and may or may not have a vertical tilt. The corrugated plates are aligned with the corrugations running horizontally at right angles to the flow. (This, however, is not always the case. Different models of OWS systems may have the plates aligned differently, depending upon the manufacturer and the purpose of the system.) The primary purpose of the plates is to provide a surface area on which the small drops of non-soluble oil dispersed throughout the water can attach and coalesce with other oil drops.

As the oily water passes through the plates, the bulk oil and larger oil particles rise quickly through the weep holes in the plates and are collected in the oil collection tower. The remaining droplets of oil larger than approximately 20-microns are deposited on the oleophilic plates by gravity. Velocity variations in the stream flow, caused by the modified sinusoidal flow path of the corrugated plates, cause the oil particles smaller than 20-microns to coalesce by collision with the particles already on the plates. As more droplets appear on the plates, they begin to coalesce and form larger oil drops. When these drops have combined to a sufficient size, they are either forced off the filter surface by the fluid or move along the plates to the high point. The difference between the specific gravities of the oil and the water permits this separation and movement of the oil drops. Small weep holes in the plates or the rib crests allow the oil to work its way to the top of the stack of plates where it collects on either the surface of the water or in a separate reservoir, depending upon the model of OWS.

Level sensor probes monitor the oil that has collected, and when preset levels have been reached, will automatically trigger discharge valves. The oil is then discharged to waste oil retention tanks for proper disposal. Backup oil sensors on the oil content monitors located near the effluent ports prevent excess amounts of oil from being discharged with the bilge-water effluent. If the levels exceed the 15-ppm discharge limit, various valves automatically shut and the effluent is rerouted to a holding tank for disposal by other means. If the oil levels are less than the 15-ppm limit, the bilge-water effluent is discharged overboard.

Whereas the Fram model contains two coalescing filter plate assemblies situated parallel to one another within the same OWS assembly, the SAREN system consists of three tanks in series. Each tank contains a number of smooth filter plates stacked vertically, on a slight incline. The first two tanks (stages) operate automatically when the OWS is running, thus collecting the oil in specific reservoirs. If they are functioning properly, the third stage tank should not collect any oil. If oil is seen in either the site glass for the second tank or for the third tank effluent, the system can be shut down and operated manually.

There are no chemical additions to the shipboard OWS's. The removal of the oil is based upon gravity separation only. The other contaminants are removed by getting caught in the oil droplets and rising to the surface to be discharged with the oil.

The Navy has been actively retrofitting all ships with OWS's and OCM's. There are fourteen ships homeported in Pearl Harbor. All but two of these have OWS's and OCM's, which were either part of the initial ships construction or installed during retrofit periods. The two remaining ships are scheduled for retrofits in the future.

3.4.2 OWS Equipment Maintenance

Maintenance of the shipboard OWS's is performed by the ship's crew in accordance with the Navy's published preventive maintenance schedule (PMS). The PMS details what work is to be done on the various pieces of equipment and when it should be performed. It also indicates which rates

should perform the work, how long it will take to do the work and other related maintenance that should be performed at the same time. PMS information for certain pieces of equipment gives step-by-step details of the work to be performed and under what conditions the work must be performed.

The PMS instructions and requirements for three of the four ships tested in the study are all identical. The fourth ship never received any maintenance material, and performed it's maintenance based upon knowledge of the ships engineering space crew members. The routine maintenance consists primarily of draining, cleaning, and lubricating the various components of the system. These maintenance requirements are to be performed either annually, semi-annually, quarterly or after a given amount of operating time. Examples of some of these requirements are as follows:

- Drain separator settling tank after every 750-hours of operation.
- Clean and inspect check valves after every 750-hours of operation.
- Clean and inspect coalescing plates and separator tank assembly after every 1500-hours of operation.
- Clean and inspect level sensor probes after every 1500-hours of operation.
- Lubricate separator pump bearings after every 1500-hours of operation.

The OWS equipment manufacturer's technical information indicates that the coalescing plates can be cleaned quickly and easily with pressurized hot water. Under normal operating conditions, they state that such maintenance is only required at one year intervals.

3.4.3 Oil Content Monitor Operation

The oil content monitor controls the amount of oil that is discharged in the OWS effluent, and ensures that it meets the required discharge limit of 15-ppm. The OCM's observed during this study were capable of being set for oil discharge limits for use either in port or out to sea. The limits between the settings differed with a discharge of 15-ppm for in port use and a limit of 70-ppm for use at sea.

The OCM consists of a backup level control sensor comprised of two electrodes. These are installed near the effluent discharge port. If the sensor detects quantities of oil greater than the designated setting, it automatically shuts a valve, therefore stopping the effluent discharge. Through a series of valve openings and closures, the effluent flow is rerouted to a waste oil holding tank for disposal through other means.

3.5 Summary

A number of different technologies exist to treat bilge-water. Some of the technologies such as the VTC/DAF and the OWS/IAF use introduced air and chemical additions to remove the oil and contaminants. Other technologies such as donuts and OWS's operate on the principle of gravity separation to remove the oil.

The Navy had been using donuts to contain the bilge-water discharges. As bilge-water is discharged into the donuts, the oil tends to separate from the liquid and collect on the surface of the water, where it is contained. Donuts function on the principal that time retention and large

volumes of bilge-water will provide a substantial dilution for the remaining liquid. However, concern by various state and Federal agencies about contaminants escaping from the donuts into the surrounding harbor waters, resulted in the use of donuts being ceased.

The Navy has installed OWS's designed to meet specific parameters for shipboard use on the majority of its ships. These OWS's operate on the principle of gravity based oil-water separation and filter coalescence. Most of the OWS's are equipped with OCM's that continually check the oil content that is being discharged in the effluent. The OCM's are designed to ensure that the bilge-water effluent meets the required discharge limit of 15-ppm of oil.

CHAPTER 4

TEST METHODS

In order to compare the effectiveness of the shipboard oil-water separator with the shore based VTC/DAF system, constituents similar to those from the Nunes study needed to be tested. This chapter is a discussion on how the constituents were chosen, as well as the reasoning behind the choices. Details of how the samples were collected, and the testing methods used by the PWC Pearl Harbor Laboratory are also presented.

4.1 Background

During the Nunes (1994) study, bilge-water from the U.S. surface ships in port was collected and stored in a 320,000-gallon Yard Oil Navy (YON) barge. Because the ships had no means of directly off-loading the waste into the YON, it would be discharged via one of two intermediate methods. The first method involved discharging the bilge-water to 75,000-gallon capacity Ship Waste Off Load Barges (SWOB's), which would then transport and off-load the liquid into the YON's. The second method involved collecting the bilge-water in 1500- to 3000-gallon tanker trucks, which would transfer the liquid to the YON. The bilge-water off loaded into the YON was not separated or isolated by ship generator or class of ship.

Nunes sampled the bilge-water from the YON as it was being processed and treated in the VTC/DAF system, taking samples at regular

intervals from both the influent and effluent sides of the system. Nunes compared the influent results to previous bilge-water characterization studies to verify similarities of bilge-water used in his study with that found throughout the rest of the Navy. The treated effluent results were compared with the COMNAVBASEPEARLINST 11345.2C discharge limits to determine the effectiveness of the treatment in reducing contaminant levels below allowable limits.

Over 150 different constituents found in bilge-water have been identified in other bilge-water characterization studies. In order to narrow down the scope of the testing and to remain within cost limitations, the number of constituents tested in the Nunes study had to be limited. Exactly which constituents to test for were determined by review and analysis of three factors. These factors were:

1. Thorough review of the bilge-water characterization studies to determine which elements occurred in "significant quantities". Nunes defined significant quantities as when a constituent was found in more than 15 percent of the samples, and in excess of 0.01-mg/l (Nunes, 1994, p. 13).

2. Review of discharge limits for 38 constituents as established in COMNAVBASE Pearl Instruction 11345.2C. This instruction was developed to prevent base activities from introducing pollutants into the sanitary waste stream which would interfere with, or upset the operation of the Fort Kamehameha Wastewater Treatment Plant facility. An additional goal of the instruction was to prevent the introduction of pollutants that were not susceptible to the treatment plant processes, and could potentially be passed directly through to the receiving waters (Nunes, 1994, p. 13).

3. Review of the federal regulation governing hazardous waste, 40 CFR 261.20 et al, in order to confirm that the bilge-water was not a hazardous waste (Nunes, 1994, p. 14).

Nunes compared the constituents that fell into each of the three above factors. If the constituent was found to fall under two or three of the factors it became an element of the study. Several other contaminants were considered in the test simply because they were a part of the treatability test offered by the PWC Pearl Harbor laboratory. The 25 constituents tested are as follows in Table 4.1.

Table 4.1 INFLUENT AND EFFLUENT CONSTITUENTS ANALYZED DURING VTC/DAF OPERATION

Arsenic	Nickel
Barium	Oil and Grease
Beryllium	pH
Cadmium	Selenium
Chemical Oxygen Demand (COD)	Silver
Chloride	Sulfide
Chromium	Thallium
Copper	Tin
Cyanide	Total Organic Carbon(TOC)
Lead	Total Petroleum Hydrocarbon (TPH)
Manganese	Total Suspended Solids (TSS)
MBAS	Zinc
Mercury	

4.2 OWS Study Constituents

This study evaluated the bilge-water that is treated in the shipboard OWS then discharged directly into Pearl Harbor. The reasoning behind

Nunes selection of the 25 constituents shown in Table 4.1 was evaluated for applicability to this project. Each of the three factors discussed in Section 4.1 was reviewed to ensure that the constituents would be acceptable in this study.

The decision was then made to test for the same contaminants, with the exception of the cyanide, mercury, COD and oil and grease. The cyanide, mercury and COD were eliminated due to cost limitations. (These tests are high cost and time consuming.) Additionally, Nunes found the cyanide and mercury quantities to be well below allowable values in the influents, which further supported the decision to eliminate them. The oil and grease test quantifies both vegetable and petroleum based oils and greases found in the bilge-water. The petroleum based oils and greases were the constituents of primary concern. Because these petroleum based quantities are also an integral part of the Total Petroleum Hydrocarbon (TPH) test, doing both the oil and grease test and the TPH test would be a duplication of cost and effort. The decision was therefore made to do only the TPH test.

The same test procedures and the same laboratory were used for this study as were used in the Nunes study. This standardized the methodologies between the two studies, further facilitating direct comparison between results.

Nunes tested for ambient air parameters using the Reid vapor analysis. Air parameters were not tested under this study due to cost and the fact that the air-associated regulations do not apply to ships.

By testing for the same influent and effluent contaminants, the data in this study can be directly correlated with the results of the Nunes study to compare the results of the OWS system treatment to that of the VTC/DAF system treatment. Because the selection of these constituents was based upon the COMNAVBASEPEARLINST 11345.2C discharge limitations, the effectiveness of the OWS in meeting these limitations will be able to be reviewed. With respect to the direct discharge into the harbor, the results of this test will give the Navy a baseline figure on the amount of these contaminants that are being discharged into the water.

4.3 OWS Sample Sources

Naval Station Pearl Harbor is the homeport for 14 ships of six different classes. There are two oilers (AO 177 class); four destroyers (DD 963 class); one guided missile destroyer (DDG 51 class); two guided missile frigates (FFG 7 class); three guided missile cruisers (CG 47 class); and two salvage ships (ARS 50 class). Twelve of these homeported ships have both oil-water separators and oil content monitors onboard. One of the oilers and one of the frigates have oil-water separators onboard but do not have oil content monitors.

Bilge-water samples were taken from four ships of different classes and various ages. Age of the ship was considered in order to test both older and newer equipment. The different ships included a guided missile cruiser which was commissioned in 1991, a guided missile destroyer which was commissioned in 1994, an oiler commissioned in 1981, and a destroyer

which was commissioned in 1980. Cost limitations prohibited sampling additional ships or one ship from each class.

In order to maintain anonymity for the ships, they have been identified as Ship B, C, D and T throughout this study. (These letters do not correspond to the order of the ships listed above.) The samples were turned in to the lab under similar headings and the lab results are identified by these same letters.

Ship B has one Fram Model OPB-10NP oil-water separator on board. The ship's Engineering Department personnel did not have, and were unable to find, the date of the installation of this equipment. The OWS equipment has been maintained per the ship's PMS, and was last cleaned in mid 1994, approximately one year before this study. PMS of this equipment, however, takes a back seat to other critical equipment, and is often put off until there is "more time". The ship's Chief Engineer intends to have the entire OWS taken apart piece by piece in order to trouble shoot several operational problems. This work has not been scheduled yet, and probably would not occur until "several other pieces of equipment were taken care of." The OWS is used on the average of once a month, when the bilge-water storage tanks are at least half full.

Ship C has two oil-water separators which were installed in April 1992 by the Pearl Harbor Shipyard. Both of the OWS's are Fram Model OPB-10NP, and are placed forward and aft of one another. Only one of the OWS's on this ship was tested. The filter plates (rack) in this unit were the same ones that were originally installed. These plates were cleaned at the end of calendar year 1994 (approximately 6 months before this test) by the ship's

crew. The cleaning process involved washing the filter rack in clean, fresh water, without using any chemicals or detergents, as per the manufacturer's instructions. The filter plates in the other unit were recently replaced with a new set of plates. The removed plates showed signs of deterioration in several locations, and had a black, greasy sludge buildup on the underside of a number of plates. The oil-water separator and related equipment have been maintained in accordance with the ships PMS.

There is only one OWS aboard Ship D. This single oil water separator is a Parmatic Filter Corporation Model 690231, and was installed during the original ship construction. Although the unit itself was built by Parmatic Filter Corporation, the actual filter plates were manufactured by Fram Filter Corporation and are identical to those used onboard the other ships. The equipment still contains the original filter plates, and has been maintained according to the ships PMS. The filters were last cleaned (using fresh water and rags) in February 1995 when the ship's crew was doing trouble-shooting work. Since it was cleaned, the OWS has only been brought on line for a total of approximately 40 hours.

The OWS on Ship T is a Fram Model OPB-10NP and was installed by the Pearl Harbor Shipyard in October 1993. The filter plates were last cleaned in October of 1994 by removing them and rinsing them in hot fresh water. Per the crew members who did the work, the filter packs appeared to be in good condition although there was a large amount of black sludge buildup on them. At the same time, the pumps were also greased, the OWS gasket was replaced, and the oil reservoir tower was cleaned. The ship

does not have any printed PMS coverage for the OWS equipment; a maintenance schedule was not supplied by the Shipyard when the unit was installed. The crew maintains the equipment based on judgment and when "there is time".

The filter age and maintenance information from the four ships tested is summarized in Table 4.2. The filter conditions were as described by the crew members who are responsible for the OWS maintenance.

Table 4.2 SHIP OWS FILTER INFORMATION

Ship	Filter	Last Maintenance	Filter Condition
B	Fram Model OPB-10NP	Mid 1994	Black sludge buildup
C	Fram Model OPB-10NP	Dec. 1994	Black greasy buildup
D	Parmatic Filter Model 690231	Feb. 1995	Black sludge buildup
T	Fram Model OPB-10NP	Oct. 1994	Black sludge buildup

4.3 Sampling Procedures

The OWS systems on the ships tested were approximately 50- to 60-gallon capacity with an operating flow rate of 10-gallons per minute. Samples were taken from the OWS influent and effluent flows at intervals that were dependent upon the estimated duration of the system operation (estimated at 1 $^1/_2$-hour) and the system flow-through-time of six minutes. (60-gallons ÷ 10-gallons per minute.) The estimated operation times were

based upon discussions with ships' engineers regarding in-port OWS operation.

A total of five samples were taken from each ship. The initial sample was taken immediately upon startup of the OWS on the influent side of the system. Because the OWS systems are primed with either fresh or seawater prior to startup, the second sample was taken from the influent side 30-minutes later. This allowed the OWS to discharge the primer water and fill completely with bilge-water. The third sample was taken six-minutes later in order to allow for the system flow through time of the second sample. Table 4.3 lists all of the sampling times and locations. These same times and locations were used for all of the ships sampled.

Table 4.3 BILGE-WATER SAMPLE TIMES AND LOCATIONS

Sample Number	Sample Time after system startup	Sample Location
1	0 min	influent
2	30 min	influent
3	36 min	effluent
4	60 min	influent
5	66 min	effluent

All samples were identified according to both the time of the sample (00, 30, 36. . .) and to the letter arbitrarily assigned to each ship. Each sample was collected in three 8-ounce Nalgene bottles and one glass 1-liter bottle. This particular sample bottle arrangement was chosen to meet the testing requirements of the PWC Pearl Harbor Environmental Lab. Each

bottle was completely filled with bilge-water and immediately stored in a cooler. Each sampling took approximately three-minutes to fill all four bottles. This was an average sample time, although the different samples may have varied slightly depending upon the flow rates from each valve. Upon completion of sampling, all of the bottles were delivered to the PWC Pearl Harbor Environmental laboratory, where they were placed in a 4°C refrigerator until the samples could be analyzed.

4.4 Analytical Methods

All analyses for this study were performed at the PWC Pearl Harbor Environmental Lab. The different testing methods used for the various tests are indicated in Table 4.4.

Table 4.4 ANALYTICAL TESTING METHODS

Analysis	Test Method
Total Metals - Determination of Metals by Inductively Coupled Plasma Atomic Emission Spectrometry	EPA SW-846 6010
pH	EPA SW-846 9040
Sulfide	SM 427 (Iodometric Method) and HACH
Total Organic Carbon (TOC)	SM 5310B (Combustion - Infrared method)
Total Suspended Solids (TSS)	SM 2540D (Total Suspended Solids dried at 103 - 105 C)
MBAS (Surfactants)	HACH (Based on SM 512A - Methylene Blue Method)
Total Petroleum Hydrocarbon (TPH)	Method 418.1 (Spectrophotometric, Infrared)
Chloride	Method 325.3 (Titrimetric, Mercuric Nitrate)

4.5 Summary

The constituents used for this study were the same as those used during the Nunes study, with the exception of the cyanide, mercury, COD, and oil and grease. These were eliminated for cost reasons. Four ships of different classes and ages were used to obtain the samples. Five samples of the bilge-water were taken from each ship over the course of 66-minutes. Three of the samples were from the influent side of the equipment, while the remaining two were from the effluent side. These samples were tested by the PWC Pearl Harbor Environmental Lab using various Standard Methods procedures.

CHAPTER 5
INFLUENT DATA COMPARISONS

The influent data found in this study will be compared with the influent data acquired during the Nunes study and the Navy-wide bilge-water characterization study. This influent comparison will allow for a determination of whether the bilge-water used in this study was typical of that found throughout the Navy and that used in the Nunes study. This determination is necessary in order to compare the effectiveness of the OWS and the VTC/DAF treatment systems.

5.1 Comparison of Study Influent Data with Previous Studies Data

The data found during this study is shown in Table 5.1 through Table 5.4. (The actual OWS lab reports are found in Appendix A.) This data will be compared with the data obtained during the Nunes study. Three of the four ships from which samples were obtained for this study were homeported in Pearl Harbor during the time of the Nunes study. However, at the time of the Nunes study, the military was holding a bi-annual Pacific Rim exercise in Pearl Harbor. This exercise involved both U.S. and Allied ships. Although no bilge-water from foreign ships was introduced into the bilge-water collection system, there were 44 visiting U.S. ships from which bilge-water was being collected.

Table 5.1 SAMPLE DATA FROM SHIP "B"

Contaminant	COMNAVBASE-PEARLINST 11345.2C Limits, mg/l	Sample No. 1 (T=00 min.) Influent, mg/l	2 (T=30 min.) Influent, mg/l	**3 (T=36 min.) Effluent, mg/l**	4 (T=60 min.) Influent, mg/l	**5 (T=66 min.) Effluent, mg/l**
Arsenic	0.5	<0.30	<0.30	**<0.30**	<0.30	**<0.30**
Barium	50	0.121	0.097	**0.147**	0.150	**0.153**
Beryllium	0.2	<.007	<.007	**<.007**	<.007	**<.007**
Cadmium	0.69	0.090	0.086	**0.092**	0.089	**0.106**
Chromium	2.77	0.126	0.164	**0.157**	0.167	**0.193**
Copper	3.38	0.65	0.62	**0.16**	0.47	**0.17**
Lead	0.69	<.30	<0.30	**<0.30**	<0.30	**<.30**
Manganese	--	0.168	0.166	**0.172**	0.176	**0.176**
MBAS	30	0.8	1.3	**0.9**	1.0	**1.0**
Nickel	3.98	0.39	0.44	**0.36**	0.45	**0.39**
pH	5.5 - 9.5	7.49	7.48	**7.57**	7.53	**7.58**
Selenium	0.9	<0.47	<0.47	**<0.47**	<0.47	**<0.47**
Silver	0.43	0.034	0.047	**0.059**	0.059	**0.077**
Sulfide	5	<0.5	<0.5	**2.3**	<0.5	**<0.5**
Thallium	0.5	<0.38	<0.38	**<0.38**	<0.38	**<0.38**
Tin	10	1.93	1.66	**1.95**	2.01	**1.91**
TOC	1,200	<10	<10	**<10**	<10	**<10**
TSS	600	26	49	**20**	46	**21**
Zinc	2.61	1.25	1.13	**0.866**	1.04	**0.882**
TPH	15	7.2	7.2	**14**	9.2	**8.0**
Chloride	8,000	13,200	13,200	**13,100**	13,300	**13,100**

Table 5.2 SAMPLE DATA FROM SHIP "C"

Contaminant	COMNAVBASE-PEARLINST 11345.2C Limits, mg/l	Sample No. 1 (T=00 min.) Influent, mg/l	2 (T=30 min.) Influent, mg/l	**3 (T=36 min.) Effluent, mg/l**	4 (T=60 min.) Influent, mg/l	**5 (T=66 min.) Effluent, mg/l**
Arsenic	0.5	<0.30	<0.30	**<0.30**	<0.30	**<0.30**
Barium	50	0.037	0.037	**0.038**	0.040	**0.041**
Beryllium	0.2	<0.007	<0.007	**<0.007**	<0.007	**<0.007**
Cadmium	0.69	0.057	0.071	**<.033**	0.068	**0.079**
Chromium	2.77	0.051	0.047	**0.057**	0.063	**0.091**
Copper	3.38	2.40	2.03	**8.38**	3.30	**2.47**
Lead	0.69	<0.30	<0.30	**0.34**	<0.30	**<0.30**
Manganese	--	0.13	0.132	**0.234**	0.141	**0.161**
MBAS	30	0.2	0.2	**0.2**	0.2	**0.1**
Nickol	3.98	2.27	2.22	**11.3**	2.36	**2.90**
pH	5.5 - 9.5	7.33	7.27	**7.31**	7.31	**7.43**
Selenium	0.9	<0.47	<0.47	**<0.47**	<0.47	**<0.47**
Silver	0.43	<0.033	<0.033	**<0.033**	<0.033	**<0.033**
Sulfide	5	<0.5	<0.5	**<0.5**	<0.5	**<0.5**
Thallium	0.5	<0.38	<0.38	**<0.38**	<0.38	**<0.38**
Tin	10	2.07	2.17	**2.33**	1.80	**1.65**
TOC	1200	20	13	**<10**	<10	**<10**
TSS	600	55	46	**25**	45	**21**
Zinc	2.61	4.33	4.52	**6.38**	4.88	**4.43**
TPH	15	91	47	**14**	70	**10.3**
Chloride	8,000	12,000	12,200	**12,400**	12,200	**12,400**

Table 5.3 SAMPLE DATA FROM SHIP "D"

Contaminant	COMNAVBASE-PEARLINST 11345.2C Limits, mg/l	Sample No. 1 (T=00 min.) Influent, mg/l	2 (T=30 min.) Influent, mg/l	**3 (T=36 min.) Effluent, mg/l**	4 (T=60 min.) Influent, mg/l	**5 (T=66 min.) Effluent, mg/l**
Arsenic	0.5	<0.30	<0.30	**<0.30**	<0.30	**<0.30**
Barium	50	0.332	0.417	**0.432**	0.273	**0.311**
Beryllium	0.2	<0.007	<0.007	**<0.007**	<0.007	**<0.007**
Cadmium	0.69	0.038	<0.033	**<0.033**	<0.033	**<0.033**
Chromium	2.77	0.059	0.062	**0.069**	0.045	**0.060**
Copper	3.38	0.36	0.39	**0.35**	0.64	**0.59**
Lead	0.69	<0.30	<0.30	**<0.30**	<0.30	**<0.30**
Manganese	--	0.269	0.302	**0.289**	0.188	**0.206**
MBAS	30	0.2	0.2	**0.2**	<0.1	**0.2**
Nickel	3.98	0.49	0.48	**0.52**	0.41	**0.43**
pH	5.5 - 9.5	7.33	7.23	**7.25**	6.94	**6.74**
Selenium	0.9	<0.47	<0.47	**<0.47**	<0.47	**<0.47**
Silver	0.43	<0.033	<0.033	**<0.033**	<0.033	**0.033**
Sulfide	5	70	65	**59**	31	**31**
Thallium	0.5	<00.38	<0.38	**<0.38**	<0.38	**<0.38**
Tin	10	<1.20	<1.20	**1.28**	<1.20	**<1.20**
TOC	1200	138	65	**70**	48	**35**
TSS	600	126	28	**17**	20	**13**
Zinc	2.61	0.425	0.190	**0.242**	0.395	**0.556**
TPH	15	1690	79.1	**19.2**	31.5	**13.9**
Chloride	8,000	5,400	4,000	**4,000**	2,000	**2,200**

Table 5.4 SAMPLE DATA FROM SHIP "T"

Contaminant	COMNAVBASE-PEARLINST 11345.2C Limits, mg/l	Sample No. 1 (T=00 min.) Influent, mg/l	2 (T=30 min.) Influent, mg/l	**3 (T=36 min.) Effluent, mg/l**	4 (T=60 min.) Influent, mg/l	**5 (T=66 min.) Effluent, mg/l**
Arsenic	0.5	<0.30	<0.30	**<0.30**	<0.30	**<0.30**
Barium	50	0.095	0.082	**0.085**	0.053	**0.068**
Beryllium	0.2	<.007	<.007	**<.007**	<.007	**<.007**
Cadmium	0.69	0.063	0.036	**<.033**	0.059	**0.043**
Chromium	2.77	0.093	0.051	**0.074**	0.092	**0.098**
Copper	3.38	0.24	<0.13	**0.36**	<0.13	**0.18**
Lead	0.69	<0.30	<0.30	**<0.30**	<0.30	**<0.30**
Manganese	--	0.225	0.122	**0.139**	0.152	**0.170**
MBAS	30	0.2	0.2	**0.2**	0.5	**0.6**
Nickel	3.98	0.57	0.45	**0.61**	0.40	**0.47**
pH	5.5 - 9.5	7.13	6.84	**6.94**	7.04	**7.15**
Selenium	0.9	<0.47	<0.47	**<0.47**	<0.47	**<0.47**
Silver	0.43	<0.033	<0.033	**<0.033**	<0.033	**0.033**
Sulfide	5	<0.5	<0.5	**<0.5**	<0.5	**<0.5**
Thallium	0.5	<0.38	<0.38	**<0.38**	<0.38	**<0.38**
Tin	10	<1.20	<1.20	**<1.20**	<1.20	**<1.20**
TOC	1,200	17	29	**27**	32	**25**
TSS	600	32	12	**12**	52	**24**
Zinc	2.61	1.61	0.537	**0.764**	0.306	**0.819**
TPH	15	300	33	**55**	110	**29**
Chloride	8,000	6,900	3,600	**3,600**	4,200	**4,150**

The data from this study is from a representative sample of the ships homeported in Pearl Harbor. The bilge-water collected during this study would also then be a representative sample of the bilge-water collected during the Nunes study. Additionally, the bilge-water from this study is from specific, known ships, whereas that in the Nunes study was comprised of a compilation of bilge-water collected from all of the ships in port during the study. (The bilge-water samples were taken from the YON's, and thus were not identifiable to specific ships or classes of ship.) For this reason, the bilge-water influent from this study is compared to the influent samples of the Nunes study to identify similarities in the sets of data before the treatment comparisons can be made. For comparison purposes, it should be noted that the data found in the Nunes study and in this study were determined using the same laboratory and the same test procedures. These test procedures were described in Chapter 4, Section 4.4.

As mentioned in Chapter 3, bilge-water characterization studies were performed on 46 Navy ships in 1992. The report from that study included ranges of the quantities of numerous constituents that could be found in bilge-water throughout the Navy. In order to show that the bilge-water quality from his studies was consistent with the bilge-water influent throughout the Navy, Nunes compared his samples to the bilge-water characterization studies by plotting the upper and lower ranges of the Navy-wide constituents with his data. (The upper and lower constituent ranges were used to show that his samples fell within the ranges of the Navy-wide data.) This same technique was used to compare the data from this study with the data from the Nunes study and the Navy-wide study.

(See Appendices B, C, and D for the data from the Navy-wide Bilge-water Characterization Study and the Nunes study.) Figures 5.1 through 5.21 show these comparisons.

In order to determine the upper and lower constituent ranges of the data, all of the values for each influent constituent were ranked in descending order. The top 10 values were used for the upper range and the bottom 10 values were used for the lower range. In data sets with less than 20 values, the lower range consisted of less than 10 values. The Nunes study consisted of 10 influent values, all of which were ranked in descending order and plotted. The data from this study consisted of 12 influent samples. These data points were ranked in descending order, and the top five and bottom five values were plotted.

Again, for comparison purposes between the different studies, it should be noted that the data found in the Navy-wide bilge-water characterization study were found using different sampling methods, different test procedures and different laboratories than those in the Nunes or this study. Sampling methods used in the Navy-wide study depended upon whether or not the ships were equipped with oil-water separators. Only one influent sample and one effluent sample were taken from each of the ships with the OWS equipment. These differences will account for some of the disparities between the data groups.

The plots of all of the data can be divided into three categories, listed below. These different categories will each be discussed separately.

- Study data which falls within the ranges of the Navy-wide bilge-water characterization study.
- Study data for which only lower detection limits were found.
- Study data components for which there were an insignificant number of Navy-wide bilge-water characterization study data points collected.

5.2 Study Data Which Falls Within the Ranges of the Navy-Wide Bilge-Water Characterization Study.

The majority of the components tested for in the study fell into this category. These components are listed in Table 5.5 and the plots are shown in Figures 5.1 through 5.13.

Table 5.5 STUDY DATA WHICH FALLS WITHIN THE RANGES OF THE NAVY-WIDE BILGE-WATER CHARACTERIZATION STUDY.

Barium	MBAS	Total Petroleum Hydrocarbons
Cadmium	Nickel	Total Suspended Solids
Chromium	pH	Zinc
Copper	Silver	
Manganese	Total Organic Carbon	

The data in Figures 5.1 through 5.13 indicate that the influent for these constituents is clearly within the ranges of the bilge-water tested Navy wide. The data from the Nunes study and this study are fairly close. It is interesting to note, however, that in 11 of the 13 plots, the concentrations of the data from this study were found to be generally higher than the concentrations found in the Nunes Study. The only constituents in which

this was not the case were the pH and the Total Organic Carbon. This lower value trend found in the Nunes study may be attributed to the fact that he was using a mixture of bilge-water from many ships. This averaged out the values of the components being tested for over a large range or number of ships (a dilution type of effect). The samples used for that study were taken from bilge-water which was originally collected from the 44 ships in port and stored in 320,000-gallon capacity YON's. It was then transferred to 75,000-gallon capacity SWOB's and finally collected in 1500- to 3000-gallon tanker trucks before being taken to the VTC/DAF treatment equipment. The bilge-water used in this study was taken directly from the ship's bilges, none of which contained over 1800-gallons at the time of the testing.

BARIUM

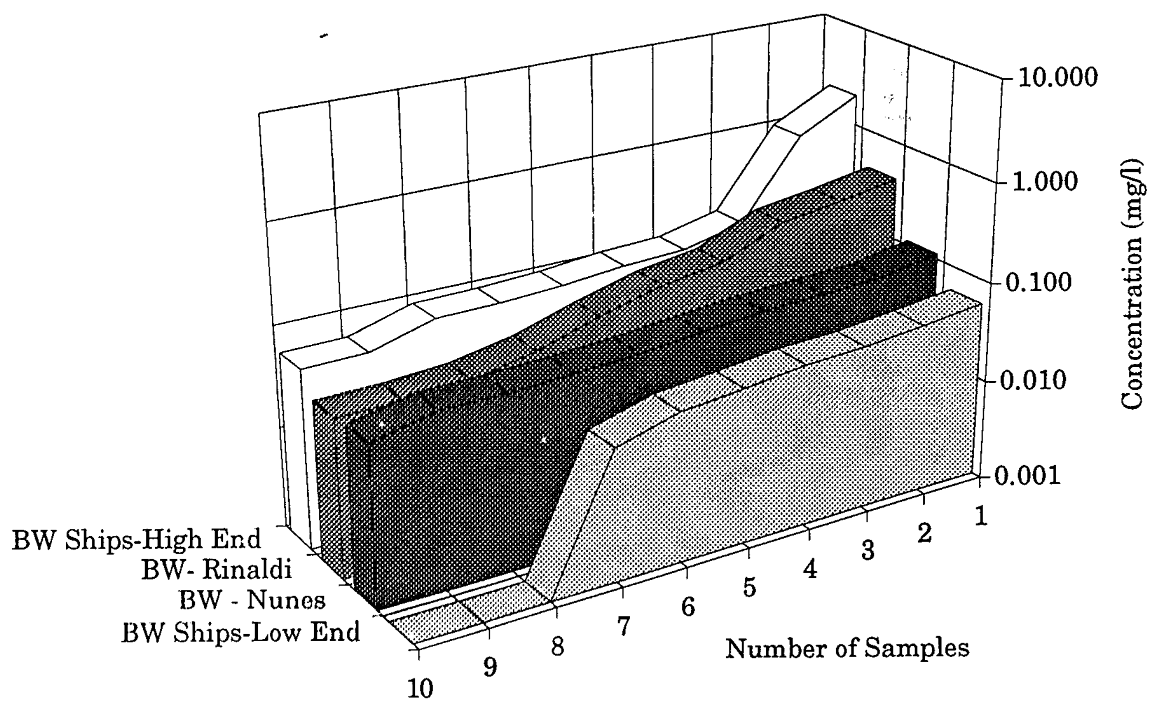

Figure 5.1 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (BARIUM)

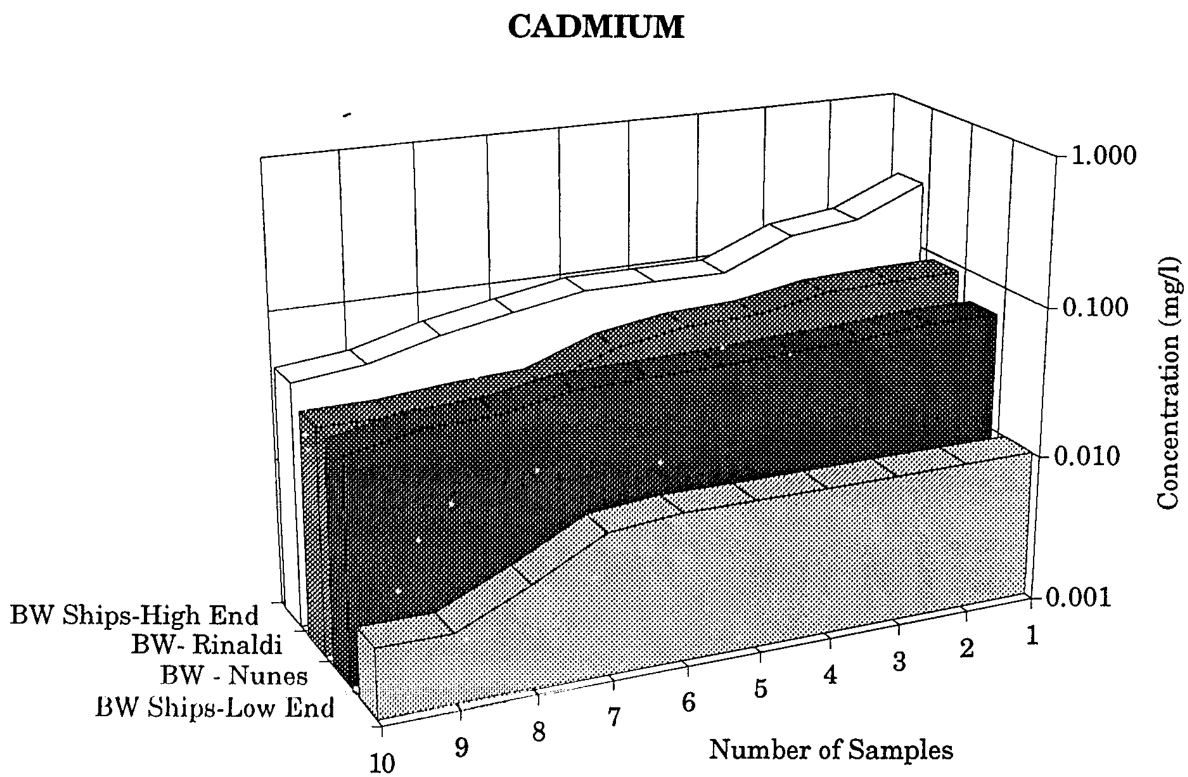

Figure 5.2 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (CADMIUM)

CHROMIUM

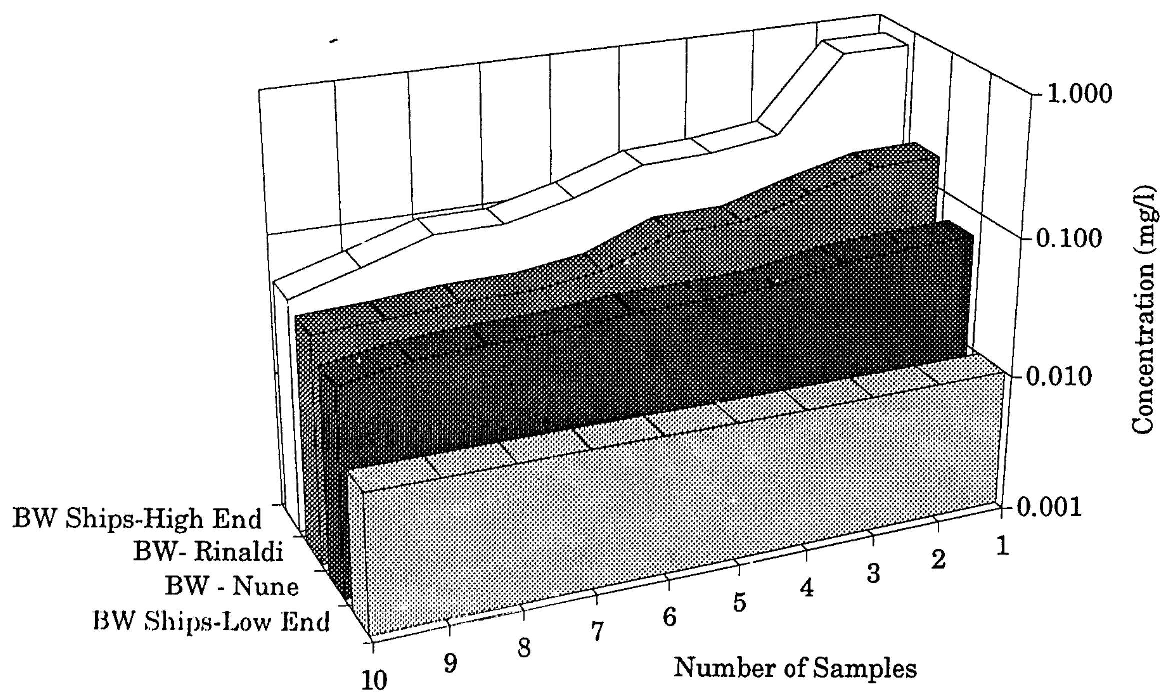

Figure 5.3 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (CHROMIUM)

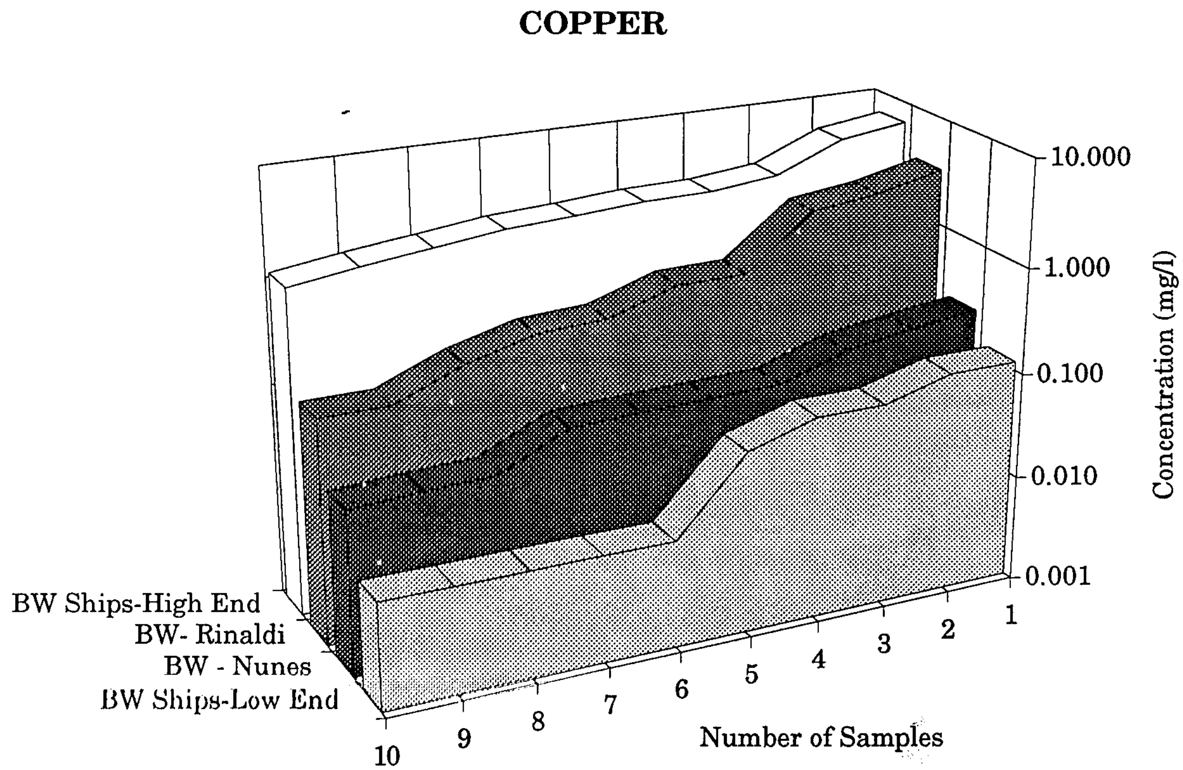

Figure 5.4 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (COPPER)

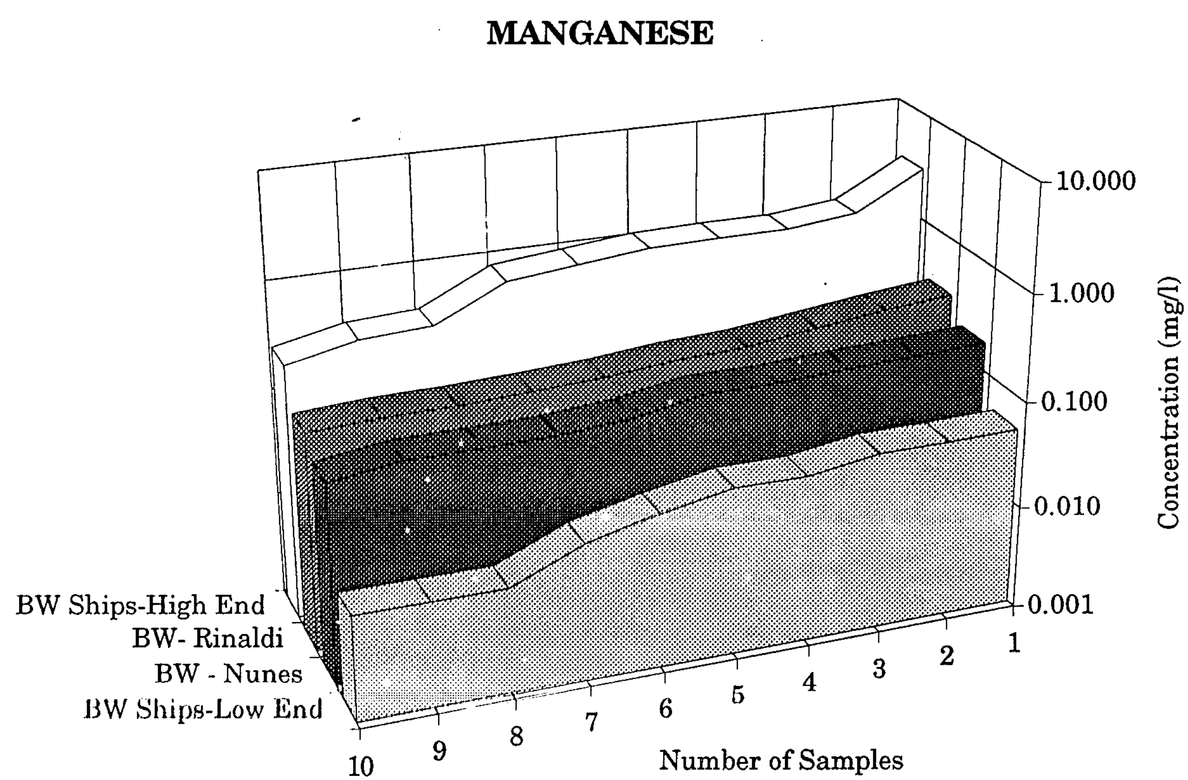

Figure 5.5 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (MANGANESE)

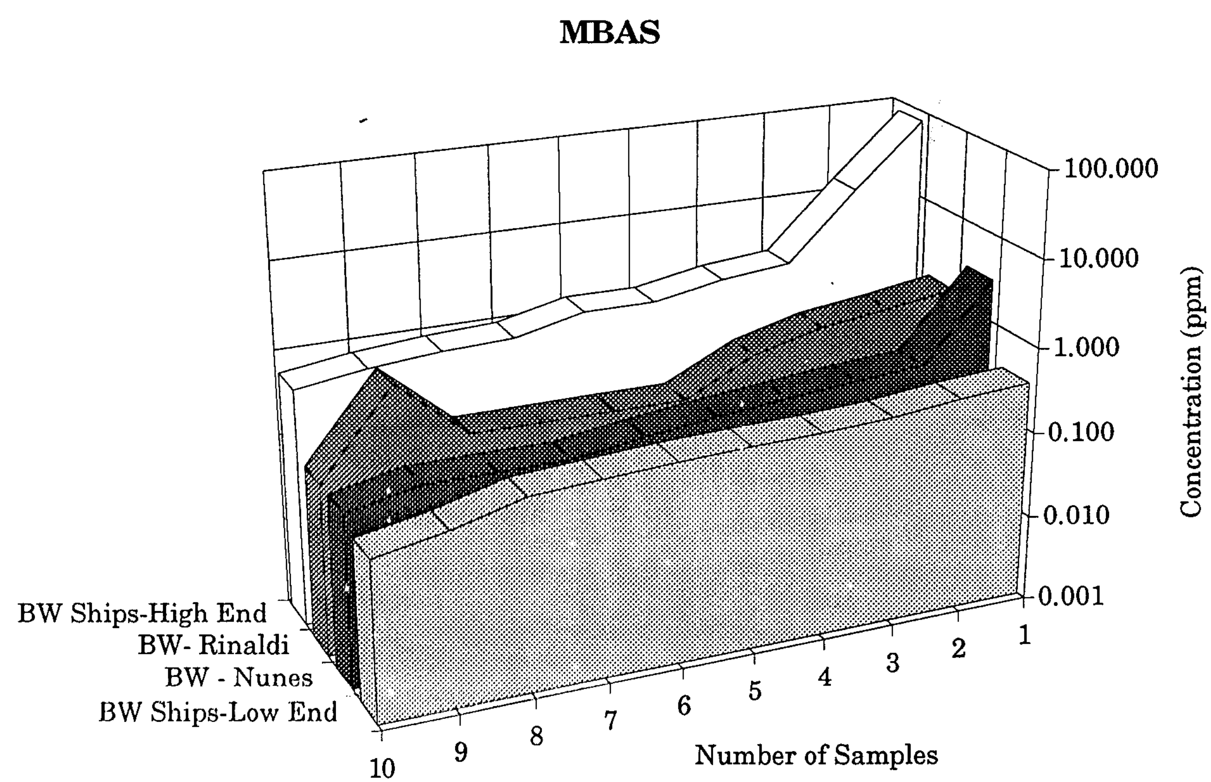

Figure 5.6 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (MBAS)

NICKEL

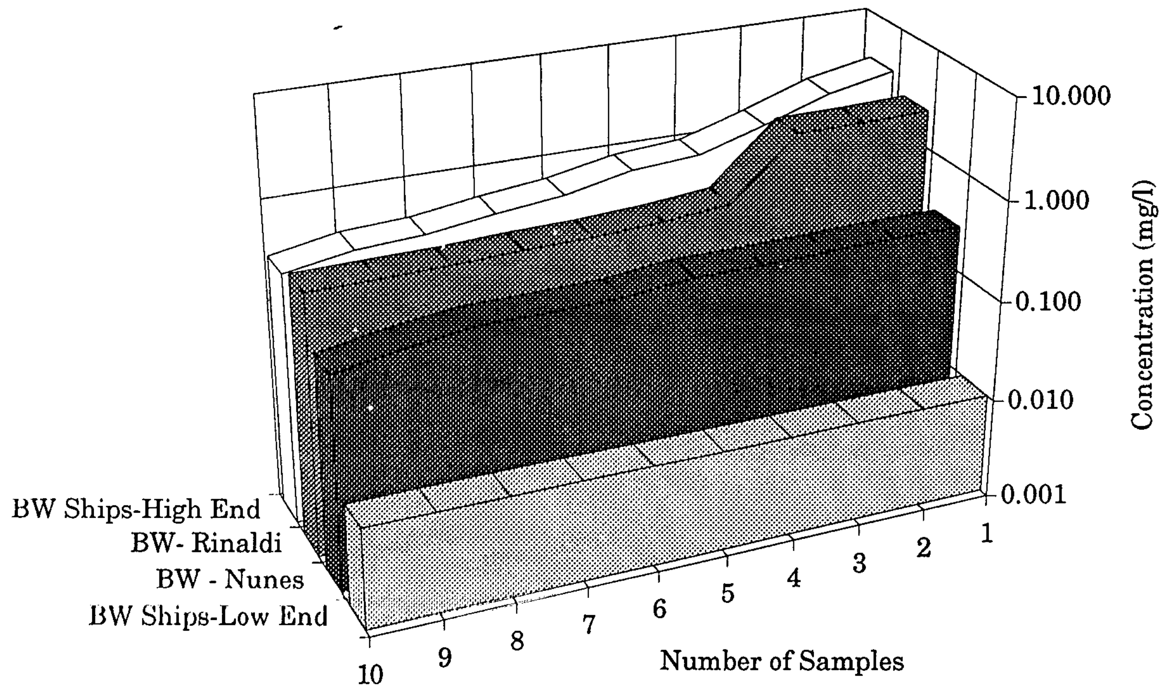

Figure 5.7 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (NICKEL)

pH

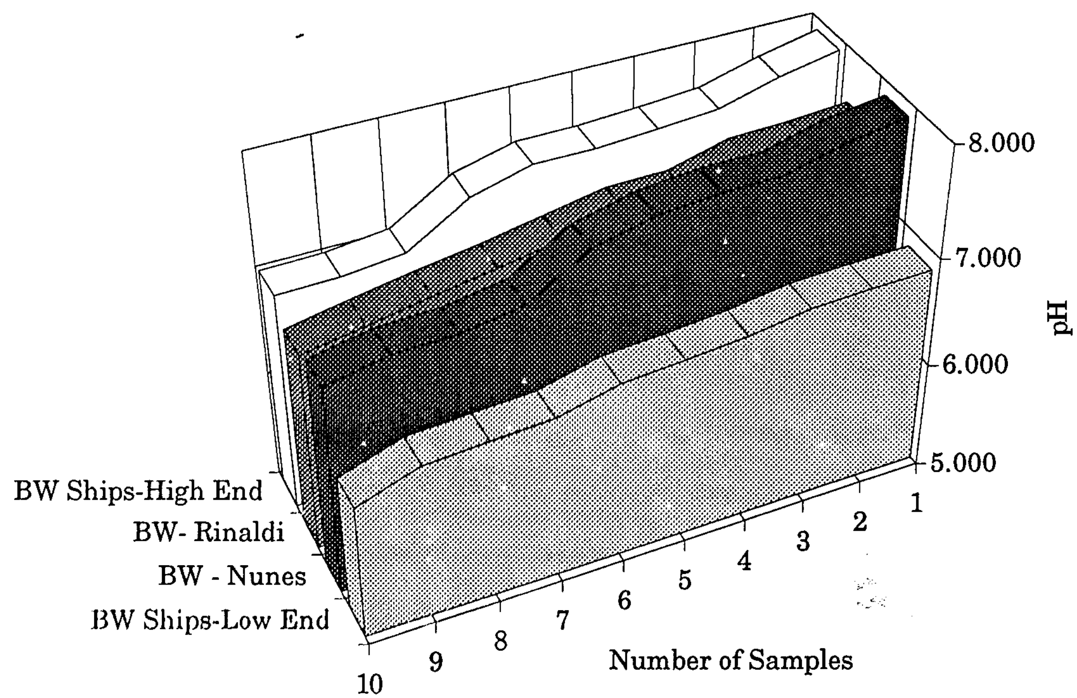

Figure 5.8 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (pH)

SILVER

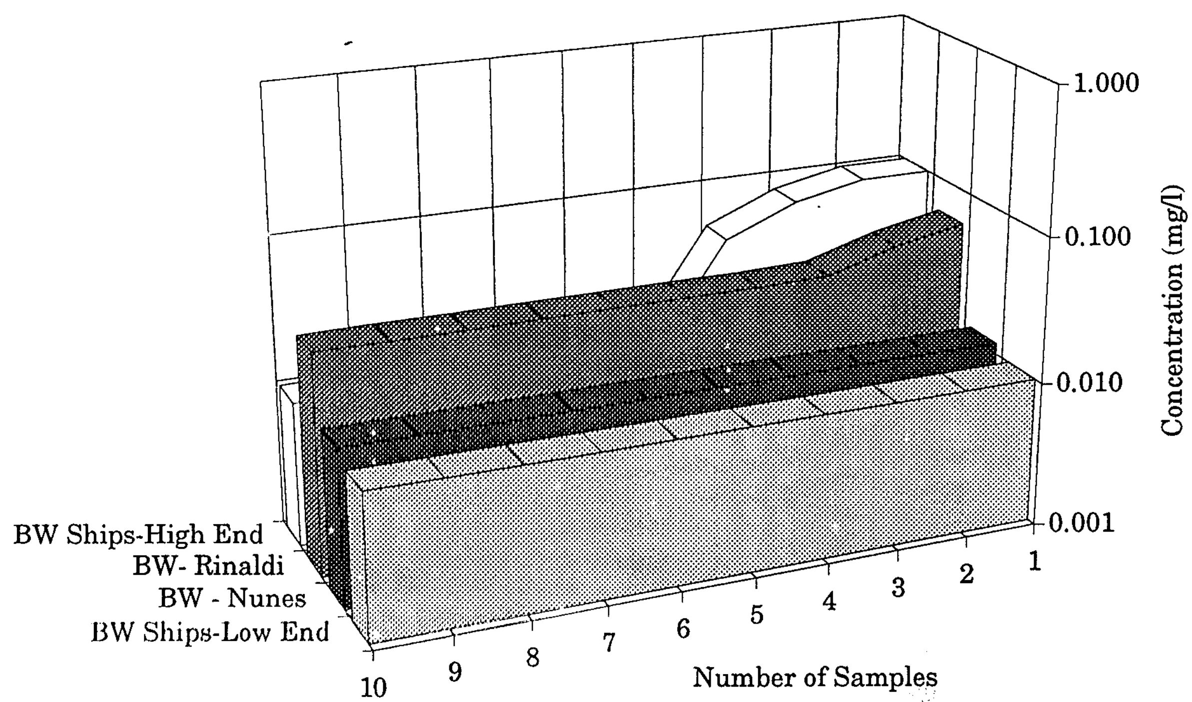

Figure 5.9 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (SILVER)

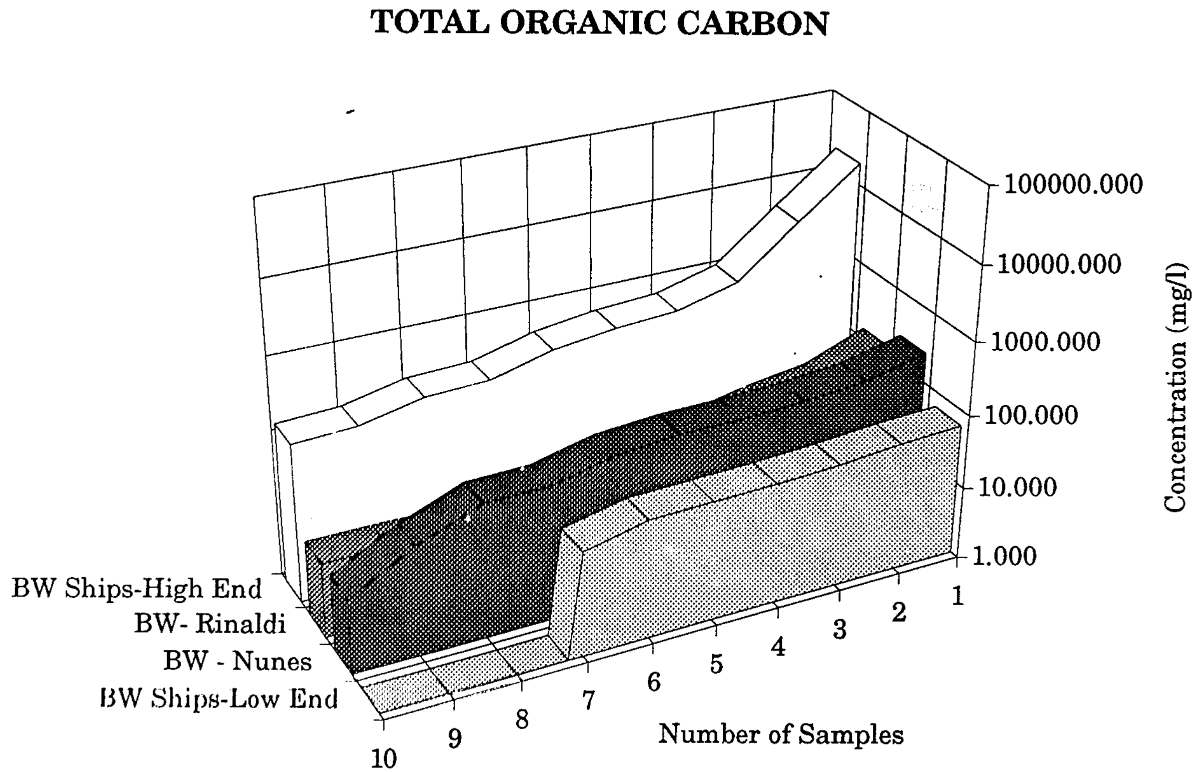

Figure 5.10 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (TOC)

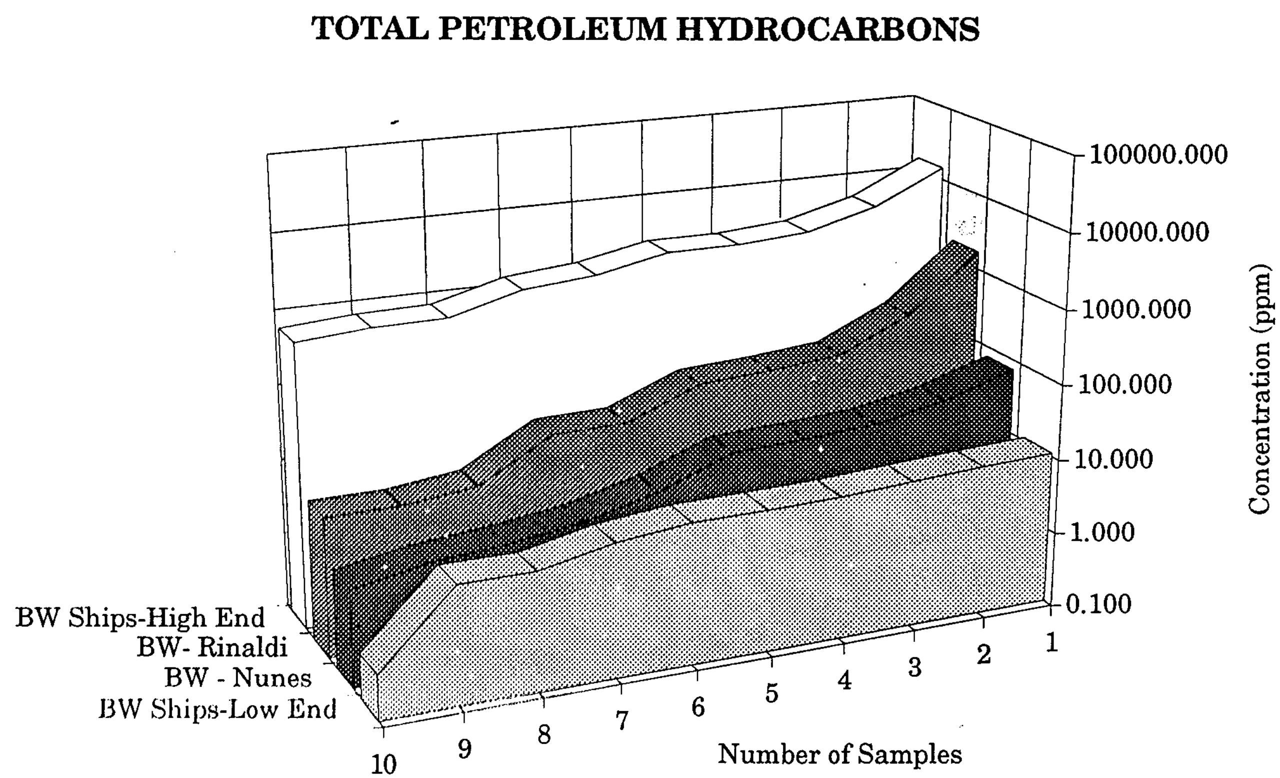

Figure 5.11 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (TPH)

TOTAL SUSPENDED SOLIDS

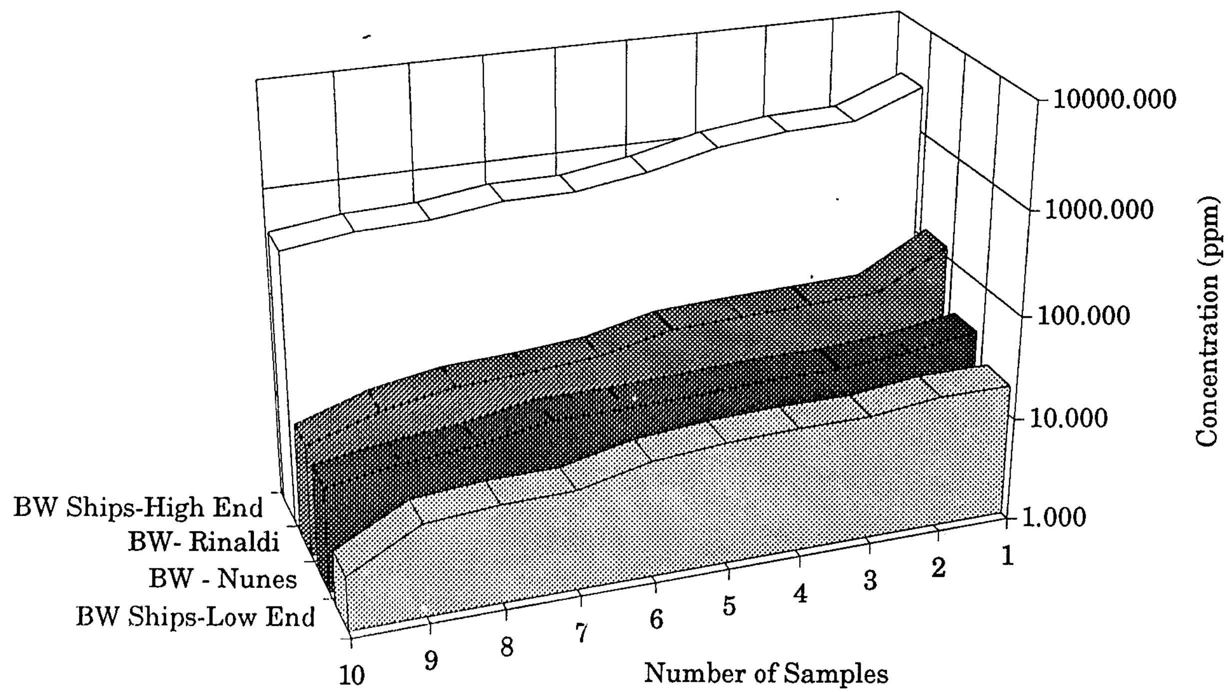

Figure 5.12 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (TSS)

ZINC

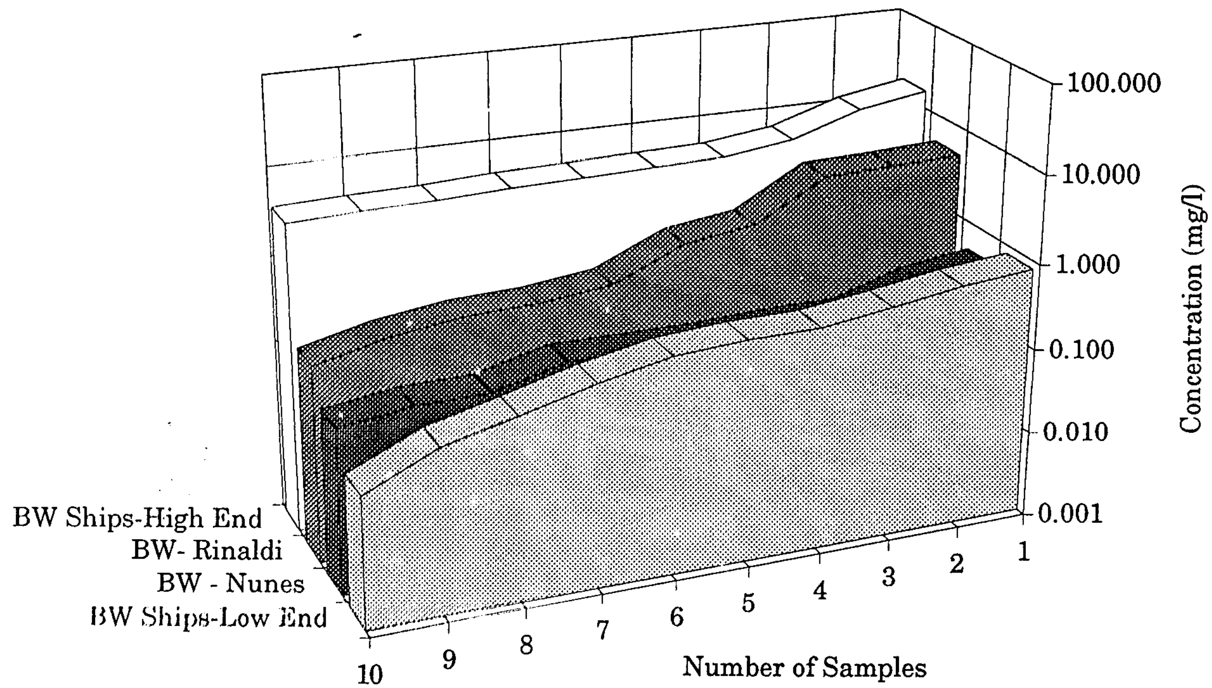

Figure 5.13 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (ZINC)

5.3 Study Data for Which Only Lower Detection Limits Were Found

The concentrations of five of the constituents tested for in both the Nunes study and this study were below the lower detection limits of the laboratory equipment. (See lab reports in Appendix A for values). The lower detection limits were therefore used as the concentration values in the plots shown in Figures 5.14 through 5.18. These constituents are listed in Table 5.6.

Table 5.6 STUDY COMPONENTS FOR WHICH ONLY LOWER DETECTION LIMITS WERE FOUND

Arsenic Beryllium	Lead Selenium	Thallium

The lower detection limit is the minimum concentration of the constituent that can be measured and reported with a 95% confidence that the value exceeds zero. Because these values were found to be less than the lower detection limit, it does not necessarily mean that there is no contaminant present. It means that the contaminant may be present in some concentration from the detection limit to none at all, with increasing uncertainty. The absence of the contaminant can not be guaranteed, so it is generally reported as less than the detection limit when it is not detected by the analytical method.

The lower detection limits for the arsenic, selenium and thallium values for this study were greater than the upper range values found in the Navy-wide study. They also were also greater than the lower detection limits used by the laboratory during the Nunes study. The different testing

methods and laboratories could account for the Navy-wide values being lower. Discussions with the laboratory personnel at PWC Pearl Harbor indicated that several of the tests performed for the Nunes study were pushed to lower than normal detection limits in order to test the effects of chemical additives later in his study. This could account for the differences between this study and the Nunes study.

The beryllium and lead lower detection limit values fell within the upper and lower limits of the Navy-wide survey. The actual concentrations of the beryllium and lead are less than or equal to the lower detection limits. Therefore, it can only be stated that the concentrations of the contaminants were lower than the upper limits of the Navy wide bilge-water survey.

ARSENIC

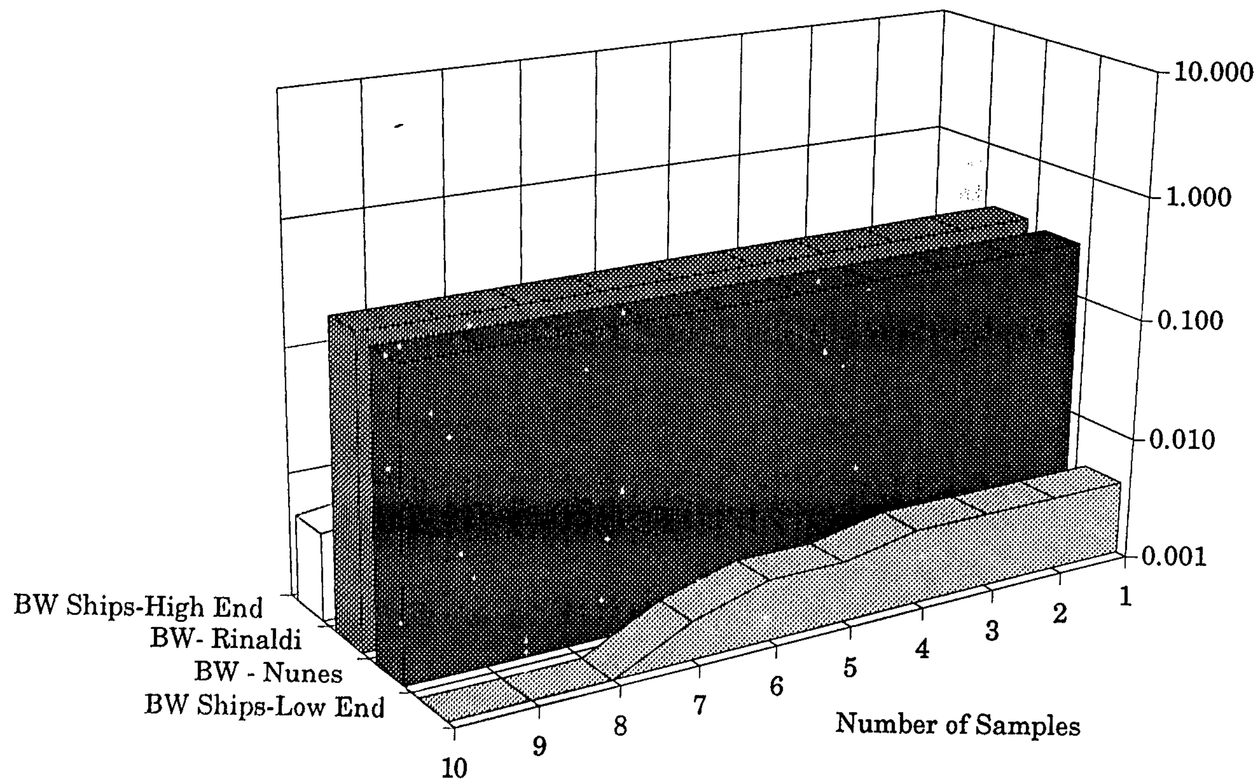

Figure 5.14 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (ARSENIC)

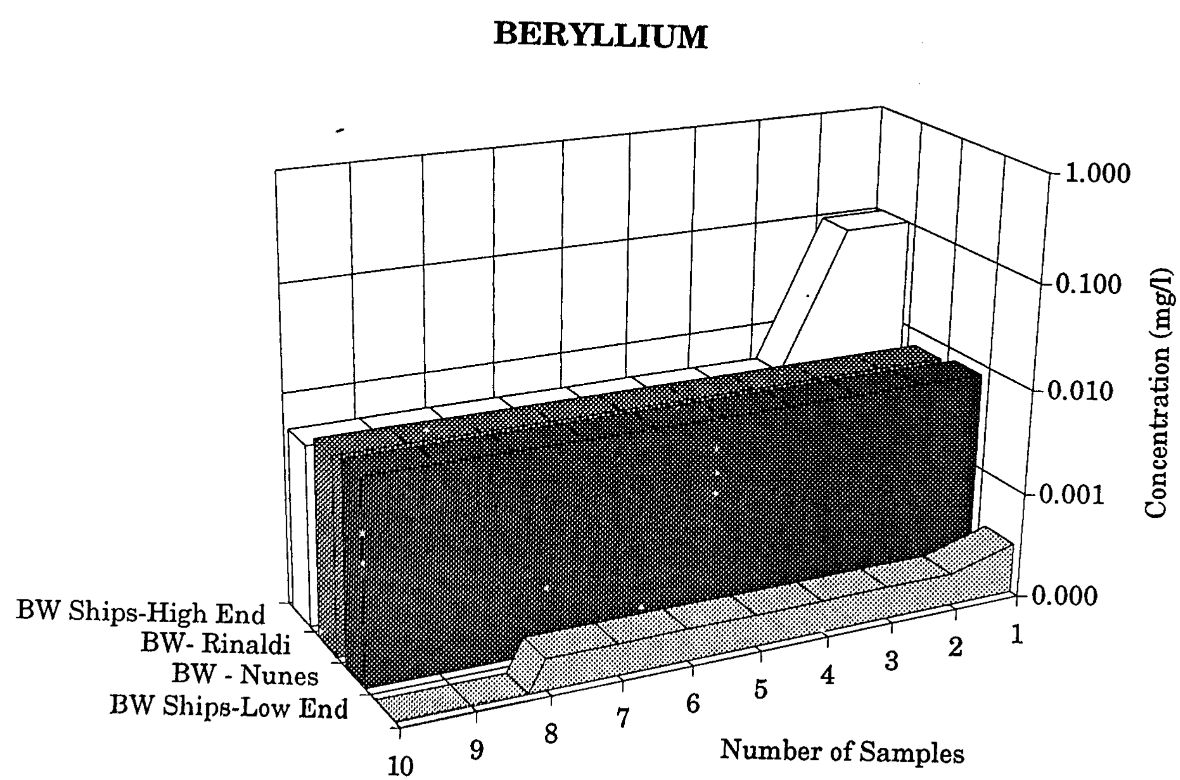

Figure 5.15 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (BERYLLIUM)

SELENIUM

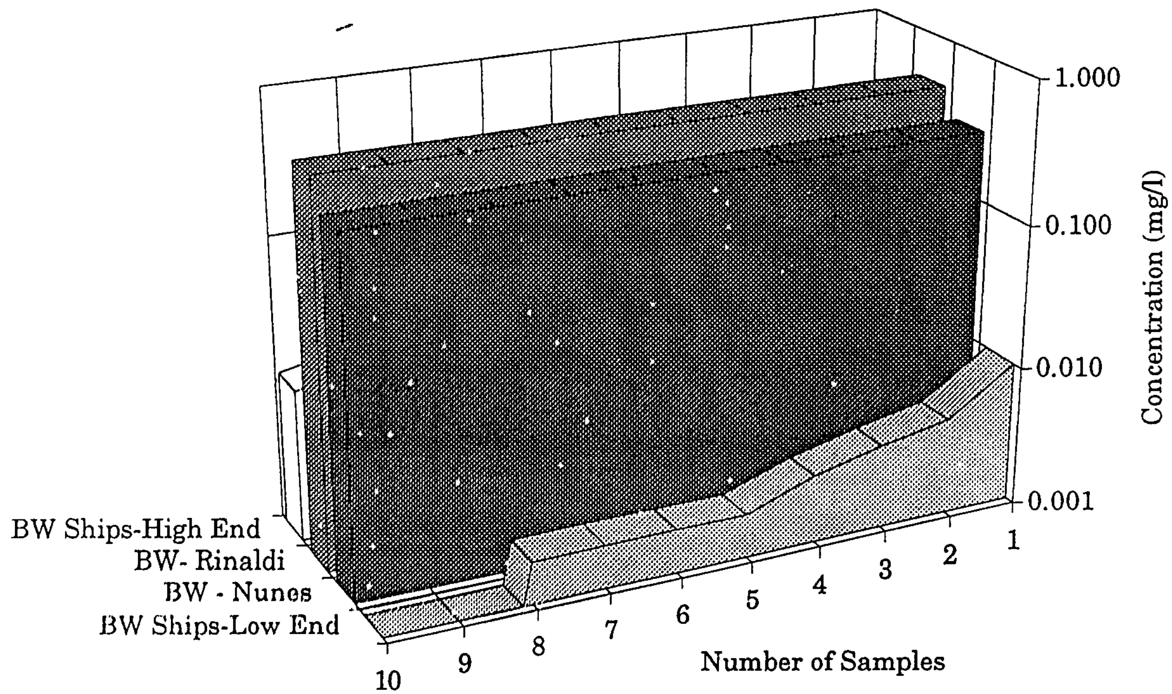

Figure 5.17 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (SELENIUM)

THALLIUM

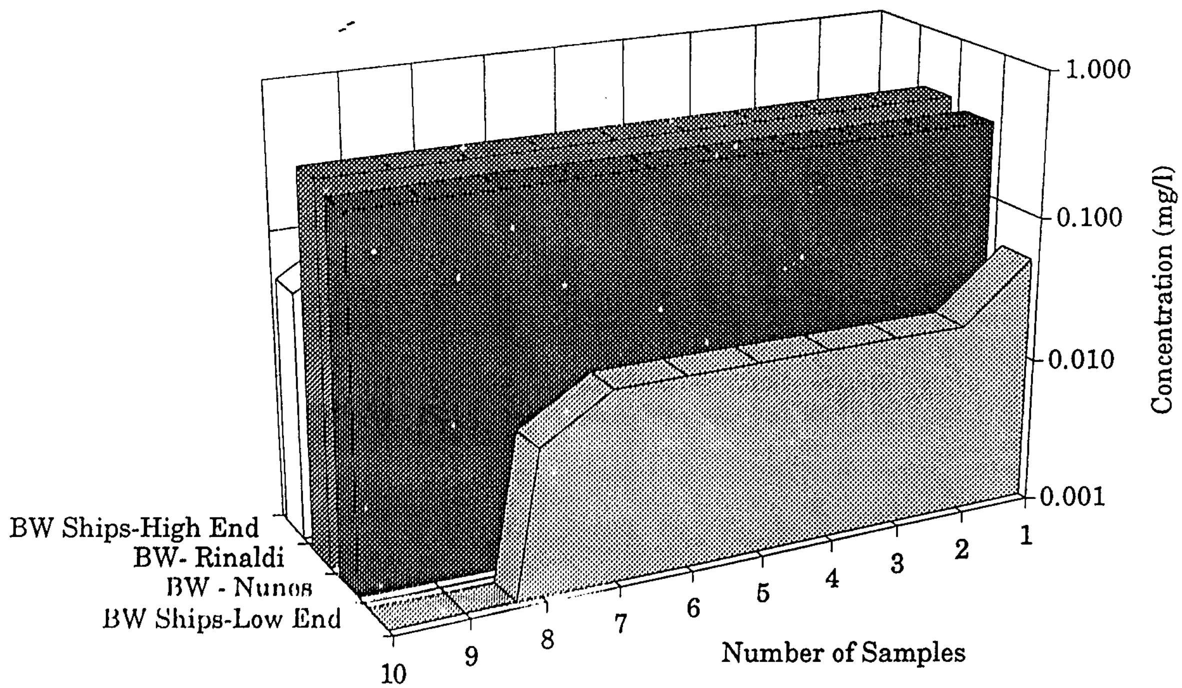

Figure 5.18 **COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (THALLIUM)**

5.4 Study Data With an Insignificant Number of Samples Collected

The Navy-wide bilge-water characterization study only had values for two tin and sulfide samples, and no values for any chloride samples. The tin and sulfide values were plotted with the data from this study and the Nunes study. The chloride values from this study and the Nunes study were plotted together. However, there is an insignificant amount of information from which to make a comparison between the influents of the studies. Figures 5.19 through 5.21 show the data plots.

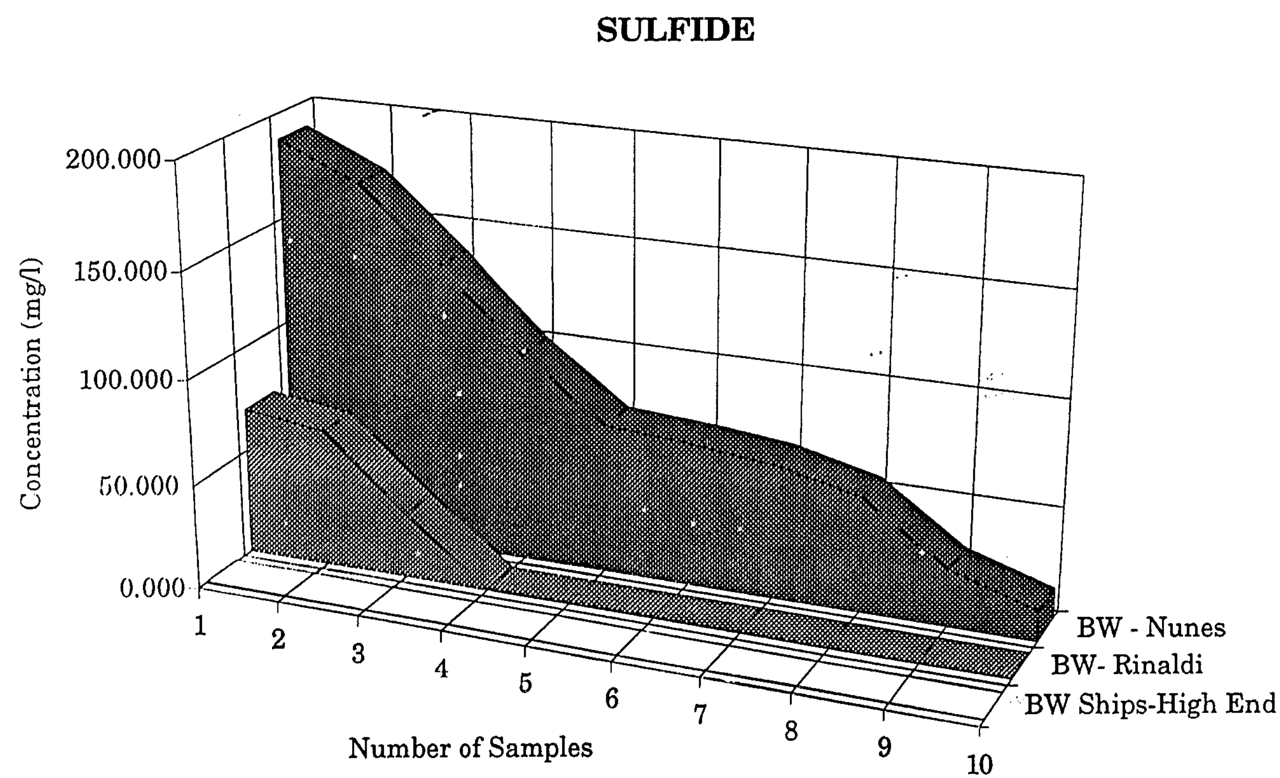

Figure 5.19 COMPARISON OF INFLUENT BILGE-WATER CHARACTISTICS (SULFIDE)

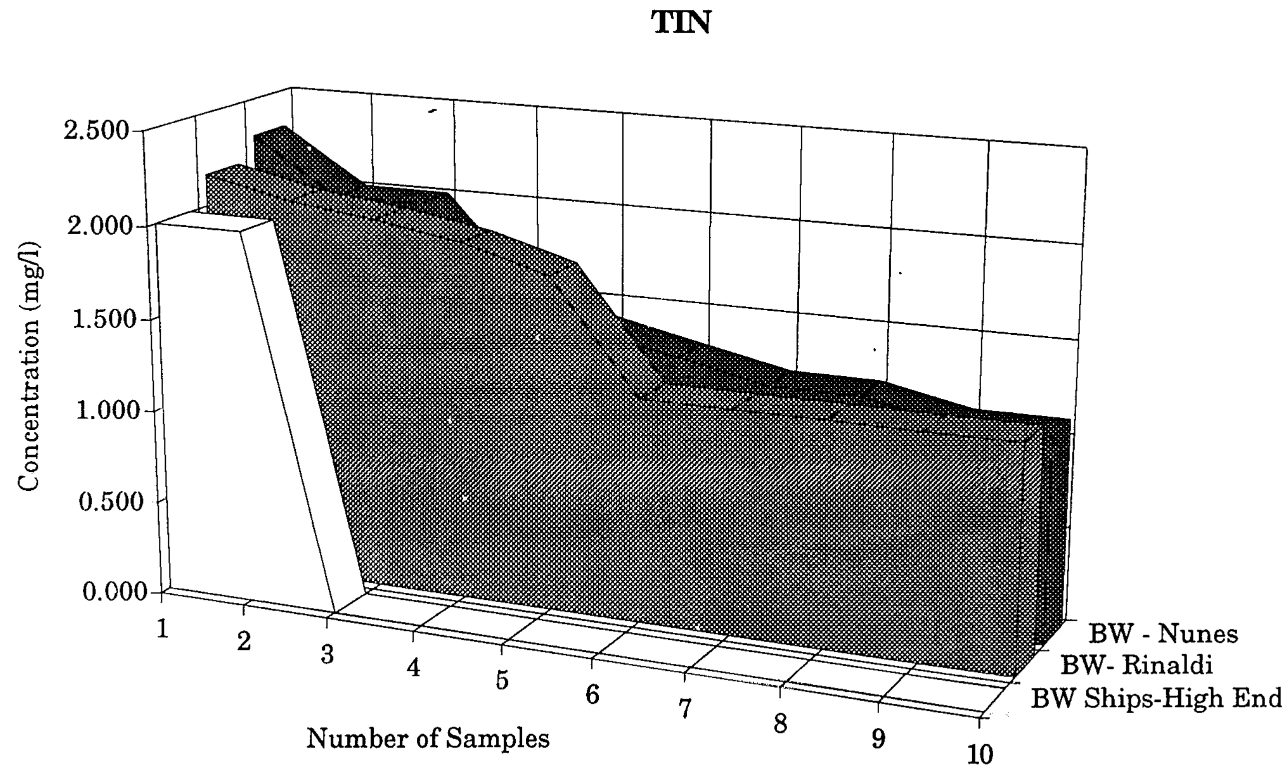

Figure 5.20 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (TIN)

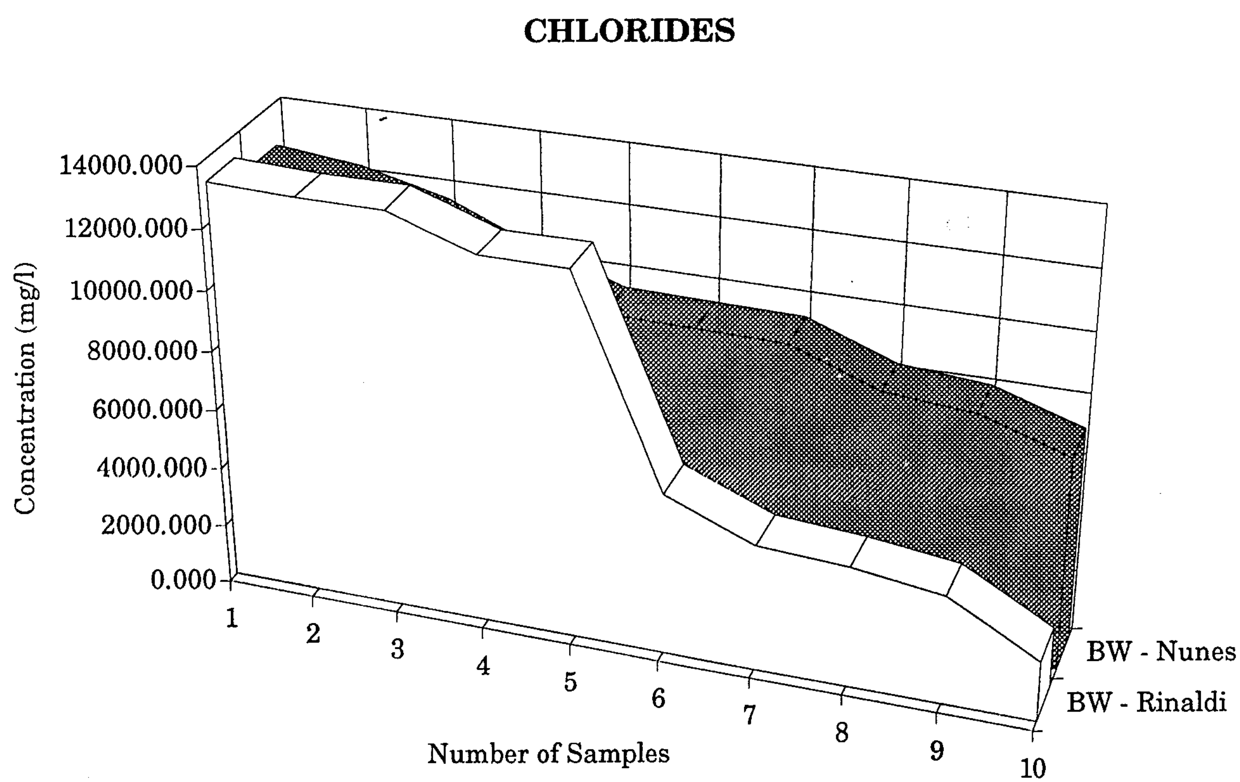

Figure 5.21 COMPARISON OF INFLUENT BILGE-WATER CHARACTERISTICS (CHLORIDE)

5.5 Bilge-Water Influent Comparison Summary

The results of the data comparisons show that the bilge-water samples gathered during this study are very similar to those gathered during the Nunes study and the Navy-wide bilge-water characterization study. There are no significant differences which would invalidate the comparisons. Based on the results of these comparisons, it can be presumed that the bilge-water tested in this study is similar to that found throughout the Navy fleet and to that tested in the Nunes study. Therefore, comparison of the treatments (VTC/DAF and OWS) effectiveness can be made based upon comparable influents.

CHAPTER 6
TEST RESULTS AND STUDY COMPARISONS

The data gathered from the four ships in this study were reviewed for any obvious trends in the influent-effluent cycles. Additionally, the influent-effluent changes were compared to those in the Nunes study. The results of these comparisons are discussed in this chapter.

6.1 General Observations

The data from each individual ship was examined in order to determine any trends or consistent changes in the constituent influent and the effluent values for that particular ship. The COMNAVBASE-PEARLINST 11345.2C discharge limits for Fort Kamehameha Wastewater Treatment Plant were compared to the test values to determine any contaminant quantities that may have exceeded the discharge limits. The PWC Pearl Harbor Laboratory equipment detection limits for each constituent were also compared to the test values on the charts in order to see a relative lower end value for each contaminant. Overall, these data reviews for the individual ships showed one possible trend in the performance of the OWS's for the individual ships or for the ships as a group. This was found in the comparison of the TPH and the TSS removed. This will be further discussed later in this section.

The individual contaminants were also examined for overall across-the-board trends. The OWS's are mechanical processes for oil-water separation. They were not designed to remove contaminants other than oil. In this study, the only contaminants that showed fairly consistent decreases in quantity from the influent to the effluent were the TPH and the TSS. Four of the contaminants which were found at the lower detection limits did not change above these lower limits. It was not possible to determine any changes less than these lower thresholds for the arsenic, beryllium, selenium or thallium. Barium was the only contaminant which showed a consistent increase between the influent and effluent quantity during all of the tests. These results, with the possible exception of the barium, were as expected.

Chapter 2 of this study covered why military ships are not required to be permitted under the NPDES permitting system. Therefore, because no permits are required, there are no contaminant discharge limits which can be applied to Navy ships discharging directly into the harbor. However, Naval Station Pearl Harbor does have discharge limits for wastes entering the wastewater treatment system, as described in Chapter 1, Section 1.2. These limits are listed in COMNAVBASEPEARLINST 11345.2C and shown in Appendix E. The maximum discharge quantities fulfill the following objectives and assist in ensuring that the Fort Kamehameha Wastewater Treatment Plant meets their NPDES permit requirements.

- Prevent the introduction of pollutants which will interfere with or upset the operation of the wastewater treatment facilities, including interfering with the disposal of sludges.

- Prevent the introduction of certain pollutants which are not susceptible to the treatment process and are passed through the treatment plant to the receiving water. (COMNAVBASEPEARLINST 11345.2C, 1989, p. 2)

The COMNAVBASEPEARLINST 11345.2C discharge limits were used for comparison purposes in this study because military ships have no bilge-water discharge limits of their own except for the TPH. These are the closest applicable limits that the Navy has with respect to the discharge of the bilge-water. It must also be remembered that if ships were to discharge their bilge-water to tank trucks for disposal into the wastewater treatment system, these limits would then apply in order to eliminate pretreatment.

Out of a total of 420 individual contaminant values that were examined and compared to the COMNAVBASEPEARLINST 11345.2C discharge limits, 33 sample values (8%) exceeded the discharge limits. These constituents are shown in Table 6.1. The reasons for these contaminant values exceeding the discharge limits will be reviewed in the individual ship discussions found in Sections 6.2.1 to 6.2.4. The remaining 92% of the values were under the discharge limits.

Table 6.1 CONTAMINANTS EXCEEDING COMNAVBASEPEARLINST 11345.2C DISCHARGE LIMITS

Contaminant	Number of Occurrences Exceeding Discharge Limits
Chloride	8
Copper	1
Nickel	1
Sulfide	5
TPH	12
Zinc	6

There were a total of 168 comparisons of the various paired constituent influent and corresponding effluent quantities. The figure 168 was derived by using four ships with 21 constituents per ship, and two influent-effluent tests per constituent. The influent and corresponding effluent values were paired and considered as one test for time 30 - 36, one test for time 60 - 66. These test pairs were used in the following comparison statistics. Of these 168 comparisons, the following statistics were noted:

- 42 of the influent-effluent tests (25%) showed a decrease in the constituent quantity in the effluent
- 59 of the influent-effluent tests (35%) showed an increase in the constituent quantity in the effluent
- 67 of the influent-effluent tests (40%) showed no change in the constituent quantities

OWS's are primarily mechanical processes that are designed to remove the oil from the bilge-water passed through them. There are no

chemical processes involved with the OWS in order to remove any other metals or contaminants suspended in the bilge-water. Therefore, the low percentage of quantities removed (25%) should not be unexpected.

The only constituent that was expected to have been removed by the OWS in any significant quantities was the TPH. As can be seen by the data found in Table 6.2, the OWS's removed the TPH to levels less than 15 ppm of TPH in 67.5% (5 out of 8) of the samples. It was also noted that the Total Suspended Solids (TSS) decreased between the influent and the effluent in 88% (7 out of 8) of the samples.

During the testing of Ship C, a filter panel that had been removed from the OWS was able to be examined. This filter panel had an extensive amount of a black, greasy build-up on both the top and undersides of the individual panels. This build-up, which could be easily removed by touch, had a greasy texture with very fine, gritty particles in it. (Significant amounts of a similar looking and feeling substance were visible in the effluent from the OWS tested on this ship.) This residue build-up could be partially attributed to suspended solids settling out of the bilge-water while in the OWS. Ship B engineering space personnel indicated that they also had found heavy black sludge in the pipes and the OWS equipment. This would also indicate that solids are settling out of the bilge-water. To further support this, it was noted that in all four ships, the TSS decreased on an average of 45% from the influent to the effluent. This was true for all but one case, in which the quantity of TSS did not change from the influent to the effluent.

Table 6.2 TPH AND TSS INFLUENT AND EFFLUENT VALUES

		Sample No.				
		1	2	3	4	5
	Contaminant	T= 00 min. Influent	T= 30 min. Influent	T= 36 min. Effluent	T= 60 min. Influent	T=66 min. Effluent
Ship B	TPH (ppm)	7.2	7.2	14	9.2	8
	TSS (mg/l)	26	49	20	46	21
Ship C	TPH (ppm)	91	47	14	70	10.3
	TSS (mg/l)	55	46	25	45	21
Ship D	TPH (ppm)	1690	79.1	19.2	31.5	13.9
	TSS (mg/l)	126	28	17	20	13
Ship T	TPH (ppm)	300	33	55	110	29
	TSS (mg/l)	32	12	12	52	24

COMNAVBASEPEARLINST 11345.2C discharge limits:

TPH - 15 ppm

TSS - 600 mg/l

The effluent samples showed an increase in contaminant quantity in 35% of the cases. Various contaminants in the bilge-water would tend to settle out of solution at different rates. The amount of contaminant that had settled out of solution, or had settled on the bottom of the collection tank, could possibly effect the amount of contaminant that was seen in the influent and the effluent. Large surges of the contaminant in the influent, created as the bilge-water was stirred up by the pump suction, could contribute to excess quantities within the OWS, which would then appear in the effluent.

Section 5.3 discussed five constituents (As, Be, Pb, Se, Tl) in which the quantities were found to be less than the laboratory test equipment lower detection limits. For the purpose of this study, the quantities of these five contaminants (or any others that were found to be less than the equipment detection limit) were taken as the equipment detection limit. These five constituents consistently remained below the lower detection limit, thus not showing any apparent change between the influent and the effluent values. Other elements also had constituent influent or effluent values which were found to be less than their respective equipment detection limits in some of the tests. When both of these two groups were combined, they constituted 58 of the 67 influent-effluent tests (87%) that showed no change in the contaminant quantities. (There were only four cases in which effluent quantities increased when the influent quantities were less than the equipment detection limits.) The remaining nine tests that showed no change were values above the equipment detection limits. To summarize this information, the majority of the cases in which no change occurred

were found to be those where both the influent and the effluent contaminant values were less than the equipment lower detection limits. Changes were too small in quantity to be determined by the test equipment.

6.2 Individual Ship Results

The data from each ship was evaluated on a ship-by-ship basis. The data was compared to the COMNAVBASEPEARLINST 11345.2C discharge limits. Based upon these comparisons and information found during discussions with ships personnel during and after the sampling periods, the conclusions were drawn. In many cases, the data from one ship differed from the data found for another ship.

It must also be remembered when reviewing the data for the ships, that only five samples were taken from each ship over a time period of 66-minutes. Those samples taken at a particular time and place, represent only the composition of that source at that time and place. Variance is to be expected in the composition of the bilge-water based upon the constantly changing liquid inputs into the bilges, as well as what is being stirred up within the bilges as suction is drawn. Various contaminants may settle out of the bilge-water solution at different rates and quantities. As the bilge-water is drawn off by the pumps, these settled contaminants are stirred up. The bilge-water levels in relation to the pump suction location could also have an effect on the contaminants in the influent liquid. Therefore, variance among the constituent quantities should be expected to be found

every time the OWS is run. The conclusions drawn from this study were based only upon the data found at the specific sampling times.

6.2.1 Ship B Data

The influent and effluent values found for Ship B, excluding the chloride values, did not exceed the COMNAVBASEPEARLINST 11345.2C discharge limits. Thirteen of the 42 influent-effluent contaminant pairs (31%) showed an increase in the effluent values after going through the OWS. Fourteen of the constituent pairs (33%) decreased in constituent quantity in the effluent, and 15 pairs (36%) showed no change between the influent and the effluent quantities. (Thirteen of these 15 pairs which didn't change, however, were found at the lower detection limits. If changes in quantities did occur with these contaminants, they were too small to be picked up by the test equipment.) Overall, Ship B showed lower percentages of contaminant increases in effluent quantity, and higher percentages of contaminant decreases in effluent quantities than the other ships.

The TPH values for Ship B were all less than the discharge limit of 15 ppm. The following facts were noticed about the TPH data for this Ship:

- The influent values were all very close at 7.2-, 7.2-, and 9.2-ppm TPH.
- The effluent value for T = 36 was 14-ppm TPH, which was almost double the corresponding influent value (7.2-ppm TPH).
- The effluent value for T = 66 was 8-ppm TPH, which was less than the corresponding influent value of 9.2-ppm TPH, but was greater than the other influent values.

The proportionately high effluent values, and the fairly constant, low influent values appear to indicate that the OWS is adding oil and grease to the influent. In order for this to occur, oil may be accumulating in the OWS. Instead of rising through the filter panels to the oil reservoir, it appears to be flushed out of the system by the bilge-water flow. There are several possible reasons that this could occur. Some of these reasons would include dirty filters which trap the oil, therefore allowing it to accumulate, clogged weep holes which prevent the oil from rising through the filter pack, and a variation of the TPH in the influent.

The TSS values for Ship B decreased between the influent and the effluent. As noted in Section 6.1, the Ship B crew indicated that they had seen a sludge buildup on the filter panels when they were cleaned. This sludge buildup was most likely a result of the decrease in the TSS quantities.

The only Ship B values which did exceed the discharge limits were the chloride quantities. Per the Ship B crew members who operate the OWS equipment, the pumps, pipes, and OWS are primed with seawater before being brought on line. Seawater generally has a chloride content in the range of 18,000- to 19,000-mg/l. Using this to prime the equipment would result in higher quantities of chlorides being seen.

6.2.2 Ship C Data

The data values found for Ship C showed both high influent and effluent values for copper, nickel, zinc, TPH and chlorides. These

contaminants all exceeded the COMNAVBASEPEARLINST 11345.2C discharge limits at some time during the testing. Overall statistics for the ship showed that 38% (16 out of 42) of the influent-effluent sample pairs showed an increase in the quantity of the various contaminants in the effluent after going through the OWS. 26% (11 out of 42) of the sample pairs showed a decrease in the quantity of the contaminant in the effluent. 36% (15 out of 42) of the pairs showed no change between the influent and the effluent contaminant quantities. Fourteen of these pairs in which no change in contaminant quantities were found, were at the lower detection limits. Any changes which may have occurred were unable to be detected.

The TPH influent values were all very high, exceeding the discharge limit of 15-ppm by at least 310% for each sample. During one interval between sample collection times for this ship, a five-gallon bucket was dropped into the bilges in order to collect a "grab" type of sample. This was done solely to see how the "grab" sample would visually compare to the influent and effluent samples already collected. The bucket was tilted on its side, pushed to the bottom of the bilge at that particular location, and then lifted out with approximately two liters of bilge-water in it. A layer of oil approximately $^1/_2$" to $^3/_4$" thick was floating on the surface of the collected bilge-water. Based upon the amount of oil collected in the bucket from the bilge, the high influent values found in the test samples were not unexpected. The OWS onboard this ship was operating effectively to remove the oil from the influent, bringing the two effluent values down to less than the 15-ppm TPH.

A filter panel from one of the OWS's onboard Ship C had recently been removed from the equipment and was able to be examined, as was discussed in Section 6.1. This panel was two-years old and was part of the originally installed OWS. It showed signs of deterioration and had a considerable amount of heavy black sludge on the individual panels. All of the OWS filter panels on this ship had been cleaned approximately six-months earlier, so this sludge build-up had occurred over a six-month time period. The decreasing effluent values found in the TSS indicate that the suspended solids are being removed from the bilge-water in the OWS. The sludge build-up on the panels and the sludge particles seen in the effluent for this ship are indicative that suspended solids are settling out in the OWS equipment. These signs are also indicative that the TSS is passing through the sludge screens, and ultimately through the OWS to the effluent.

A probable cause for the high copper, nickel and zinc quantities would be that the ship's piping was made out of a copper/nickel combination metal. The bilge-water may have been picking up copper and nickel as it flowed through the system. The ship also used zinc anodes in the bilges to prevent corrosion. The corrosion of the anodes might contribute to the quantities of zinc seen in the samples.

The two OWS systems onboard Ship C were primed with sea water before use. As with Ship B, the sea water would add to the chloride content found in the samples.

6.2.3 Ship D Data

Excluding the sulfide and the TPH data, the constituent values found for Ship D were all within the COMNAVBASEPEARLINST 11345.2C discharge limits. Overall statistics for this ship showed that 33% (14 out of 42) of the influent-effluent sample pairs showed an increase in the quantity of the various contaminants in the effluent after going through the OWS. 24% (10 out of 42) of the sample pairs showed a decrease in the quantity of the contaminant in the effluent. 43% (18 out of 42) of the pairs showed no change in the contaminant quantities between the influent and the effluent. Fifteen of the 18 pairs were found to be at the lower detection limits, so any changes in contaminant levels could not be readily identified.

The OWS was working to remove the TPH from the bilge-water. The TPH in the first sample was reduced significantly, although it slightly exceeded the limit of 15 ppm. The second sample TPH level was brought down to less than the discharge limit.

The sulfide values were the only unusually high values found for Ship D. These data points were all at least six times higher than the COMNAVBASEPEARLINST 11345.2C discharge limits. The values ranged from an initial influent value of 70-ppm to a final effluent value of 31-ppm. The sulfides are a result of a chemical reduction of sulfates under anaerobic conditions as per the following equations:

$$SO_4^{--} + \text{organic matter} \xrightarrow{\text{bacteria}} S^{--} + H_2O + CO_2$$

$$S^{--} + H^+ == HS^-$$

$$HS^- + H^+ == H_2S$$

Sulfates are often found in petroleum products. The TPH values for this ship were very high, indicating a strong presence of petroleum products, and thus sulfates. The TOC is a means of measuring organic matter present in a substance. The values found for the TOC were higher for this ship than for the other ships, although they did not exceed the COMNAVBASEPEARLINST 11345.2C discharge limits. The presence of these two constituents combined to make conditions very favorable for the anaerobic reaction resulting in sulfides.

6.2.4 Ship T Data

The majority of the Ship T OWS influent and effluent contaminant values were less than the COMNAVBASEPEARLINST 11345.2C discharge limits. The only values to exceed these limits were one zinc values and all of the TPH values. The overall statistics for this ship showed that 38% (16 out of 42) of the influent-effluent sample pairs showed an increase in the quantity of the various contaminants in the effluent after going through the OWS. 17% (seven out of 42) of the sample pairs showed a decrease in the quantity of the contaminant in the effluent. 45% (19 out of 42) of the pairs showed no change in the contaminant quantities between the influent and the effluent values. Of the 19 pairs found without any change, 16 of them were found at the lower detection limits where actual changes could not be identified.

The TPH values were all found to be higher than the discharge limits. At times T=30- and 36-minutes, the TPH quantity increased in the effluent. The second set of data, at T= 60- and 66-minutes showed a

significant decrease in the effluent TPH quantity. These values for the TPH were very random and inconsistent when compared to the other ships results. The ship's crew members responsible for maintaining the OWS equipment indicated that there were no OWS operating problems of which they were aware.

The values for the TSS were examined to determine if the plates could be dirty and thus not functioning correctly. These values showed a drop in the TSS effluent contaminant quantities for one pair of tests. This would indicate that some of the suspended solids are settling out inside the OWS. The plates were last cleaned over six-months prior to this test. At that time, there was a greasy sludge buildup on the filter panels. If this sludge buildup was again occurring within the OWS, it could be acting to prevent the oil from reaching the oil reservoir, and causing it to collect within the filter panels. When this buildup of oil was big enough, it would then be forced out with the effluent, resulting in the increased TPH value seen at T=36-minutes.

6.2.5 Individual Ship Data Summary

All of the ships showed results that varied to a certain degree in comparison with the other ships. The primary summarization that could be made from these reviews is that the OWS's are not removing contaminants with any regularity. However, as was stated in Section 6.1, the OWS's are a purely mechanical process. Therefore, they should not be expected to be removing vast quantities of the various contaminants other

than the TPH. For the most part, the OWS's are operating effectively at removing the TPH, although the removal quantities are not always or consistently brought down to the required discharge limit of 15-ppm.

The TSS values indicated evidence of solids settling out within the OWS. This was further evidenced by the visual conditions of the panels, on which the solids had created a sludge build-up. The sludge in the effluent sample acted to support this also.

6.3 Oil Content Monitor Observations

The oil content monitors were observed during the operation of the OWS and the collection of the bilge-water samples. Three of the four ships tested had OCM's that were integral to the control panel. These OCM's did not have a digital display showing the oil contents in the effluent. The fourth ship tested, Ship D, had a separate digital readout OCM.

During the operation of the OWS on the fourth ship, the OCM readout was constantly changing and varying between both high readings and low readings. The readouts changed approximately every two- to three-seconds, and would vary significantly. An example of how the oil content readout sequence varied would be as follows: 4, 12, 2, 67, 28, 37, 11, 7, 7, 19, 47, etc. The readouts did not show any order or obvious trend. Additionally, at the rate the discharge quantities were changing on the readout, it would have been very difficult for the diverter valve to open and close at a similar pace. The OCM may have been operating in a manner that would "smooth out" the effluent TPH discharges, trying to maintain an average discharge

of less than 15-ppm. It is also possible that this particular OCM was not functioning properly. The other ships did not have this type of OCM, so a comparison could not be made.

The diverter valve was observed closely during this OCM operational period. Although it was enclosed, the valve did not appear (by either feel or sound) to be rerouting the effluent. However, this is not to say that it was not doing such; it was just not readily apparent from observations. The actual TPH quantities did decrease in the Ship D effluent, although the time T=36-minute effluent exceeded the 15-ppm limit.

6.4 Comparison to Data from the Nunes Study

The contaminant values found in the OWS influent and effluents were compared to those found in the Nunes study. (See Appendix D for the values from the Nunes study.) The treatment process used in the VTC/DAF involved the addition of chemical additives to remove the contaminants in the bilge-water. Due to this fact, it is to be expected that the values from the Nunes study will be less than those from this study.

There were several primary differences in the analysis of the data from the Nunes study and this study. The first involved the testing of the constituents in the effluent during the Nunes study. When laboratory analysis of the 25 bilge-water influent constituents concluded that the quantities were less than the equipment lower detection limits, an effluent analysis was not performed for that particular constituent. Because of this, each effluent sample of Nunes' was tested for only 10 contaminants. (The

figure 10 is an average because some samples may have had eight contaminants tested for, while others had 12.)

The second difference involves the four extra constituents not examined in this study. These values included the mercury, cyanide, oil and gas, and COD. They were eliminated from this study as described in Chapter 4, Section 4.2. For comparison purposes, these values were not considered in the calculated percentages for the Nunes study.

Another difference involved the levels of testing that the laboratory performed for the Nunes study. The laboratory was able to push the equipment detection limits, using the same tests and equipment, to lower values for many of the Nunes samples. This was done in order to determine the extent of the chemical additive effectiveness in the VTC/DAF. The limits were not pushed to these extremes for this study since there were no chemical additives. This resulted in several of the constituent quantities in the Nunes study having lower values than the detection limits from this study.

Figures 5.1 to 5.20 showed a graphic comparison of the influent values from both the Nunes study and this study. The Nunes values, excluding the beryllium, lead, and TOC, were all generally lower than the values from this study. The beryllium, lead, and TOC were slightly higher. A few random values of the contaminants in the Nunes study may have exceeded the values from this study. The general trend, however, was of lower influents.

The primary effluent values in the Nunes study which showed contaminant quantity increases were the TOC, TSS, and MBAS. Two

chloride and one manganese value also showed increases. This equated to an average of only 25% (23 of 92 contaminant pairs) of the total number of influent-effluent sample pairs showing an increase in the effluent contaminants. This study averaged 35% (59 of 168 pairs) of the contaminants showing an increase in quantity in the effluent. This difference was not unexpected. As stated above, the treatment used in the Nunes study used chemical additives to remove contaminants. The OWS, being a purely mechanical process, is not designed to remove contaminants other than oil.

An increase in TOC was noted in the VTC effluent by Nunes. Nunes determined that the source of the additional TOC quantities was the free oil contamination already present in the VTC (Nunes, 1994, p. 134). The use of $Fe_2(SO_4)_3$ in the VTC/DAF appeared to be responsible for some of the increase in the MBAS concentration in the effluent following treatment (Nunes, 1994, p. 136). Nunes indicated that the increase in the effluent TSS quantities were possibly due to how the VTC/DAF system was operated. The function of the VTC/DAF was to produce a solid sludge that contained the influent contaminants. Disruption of the sludge by dissolved air or the scraper arm contributed to the higher effluent TSS concentrations (Nunes, 1994, p. 136).

The effluent contaminant quantities found in this study were significantly more random than those in the Nunes study. The sample effluent values from this study did not show a clear decreasing trend as did those in the Nunes study. This would be expected due to the lack of chemical additives. It is interesting to note that without the added

chemicals, the OWS removed only 1/3 as many contaminants as the VTC/DAF treatment. Only 25% (42 out of 168 pairs) of the contaminant quantities were reduced in the OWS effluent verses 75% (69 out of 92 pairs) in the VTC/DAF effluent.

Indications of the solids (TSS) settling out of the bilge-water in the OWS, shown by a decrease in the effluent quantities of TSS, were presented in this study. This was opposite of the findings in the Nunes study, which found increases in the TSS in the effluent. These increases in the Nunes study, however, were partially attributable to disturbances of the sludge.

The overall differences between the two studies were as expected. The purely mechanical process of the OWS is not as efficient at contaminant removal as the chemical processing in the VTC/DAF. The OWS is a closed system that can not perform chemical treatment.

6.5 Summary

The results of the tests that were performed on the OWS's, and comparisons with the COMNAVBASEPEARLINST 113455.2C discharge limits and the Nunes study data were presented in this chapter. The data indicated a possible relationship between the TPH and the TSS removed, and the resulting effect on the OWS's performance. Out of a total of 420 individual contaminant tests, only 92% (387 samples) were within the COMNAVBASEPEARLINST 113455.2C discharge limits.

The overall statistics indicated that 25% of the 168 tested influent-effluent pairs showed a decrease in contaminant quantity after being

processed through the OWS, 35% showed an increase, and 40% showed no change. The values showing no change were in part due to quantities found at the lower equipment detection limits. Exact quantity changes in these cases could not be determined due to equipment limitations. These statistics were as expected, due to the fact that the OWS is a mechanical process designed to primarily remove oil from the bilge-water.

The data was reviewed on an individual ship basis. Ship B data was found to have the highest amount of contaminant quantity decreases in the effluent and the least amount of contaminant increases. Each ship had different contaminants increasing and decreasing throughout the tests. However, it was found that the TSS appeared to be settling out of the bilge-water while in the OWS. This was evidenced by the decreasing values between the influent and the effluent, and by the sludge build-up on the filter panels.

The data comparison with the Nunes study found that the VTC/DAF removed more contaminants from the bilge-water than the OWS. The VTC/DAF removed contaminants in 75% of the effluent cases. The OWS removed contaminants in only 25% of the effluent samples. Again, this is as expected, since the VTC/DAF used chemical additives whereas the OWS is purely a gravity based oil-water separation system.

OCM's were present on all four ships, however only Ship D had an OCM with a digital readout of the oil levels. The oil contents in the effluent varied from high to low levels, changing quantities rapidly with no order or obvious trend.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

Navy ships are authorized to discharge bilge-water effluent directly into the harbor if it has been processed through an OWS with an OCM. OWS's were designed to remove TPH from the bilge-water effluent to levels of 15-ppm or less. However, they were not designed specifically to remove other contaminants in the bilge-water. The discharge of these other contaminants and excess oil into the harbor is of concern to the Navy. The primary goal of this study was to quantify the levels of TPH and other specific contaminants found in bilge-water, and determine the effectiveness of the OWS in removing these from the bilge-water. The operational performance of the OWS was examined to make a comparison of its efficiency to the efficiency of the VTC/DAF system (as determined in the Nunes study). These figures can provide the Navy with information on levels of contaminants that are being discharged into the harbor with the bilge-water effluent.

In order to make the efficiency comparison, it had to first be shown that the bilge-water in this study was representative of the bilge-water used in Nunes' study (Nunes, 1994). This was done by comparing the influent characteristics of the two studies. These influents were also compared to the influent characteristics found in the Native American Consultants, Inc. Navy-wide bilge-water characterization study (Native American Consultants, Inc., 1992) to find out if the bilge-water used for the studies was representative of bilge-water throughout the Navy. After determining

that the bilge-water was a representative sample, the performance and effectiveness of the OWS system was evaluated and compared to the VTC/DAF system.

The removal rates of the various contaminants were examined for both of the systems. As was to be expected, the contaminant removal rates from the OWS were less than those of the VTC/DAF. Although there was no obvious trend in the removal of a majority of the contaminants by the OWS, the TSS and the TPH did stand out. TPH was removed from the bilge-water, however, in three of the eight tests (37.5%) it was not removed to levels below the required 15-ppm. TSS appeared to decrease between the influent and effluent as the bilge-water was processed through the OWS. There were also other indications that the TSS was collecting within the OWS.

The comparison between the OWS and the VTC/DAF showed that, as expected, the OWS was not as efficient at removing the contaminants. Whereas the quantities of contaminants were reduced in the effluent of the VTC/DAF in 75% of the test cases (69 out of 92 pairs), they were reduced in the OWS in only 25% of the cases (42 out of 168 pairs).

The conclusions and recommendations formed based upon the results of this study are presented in this chapter.

7.1 Conclusions

Based upon the results of this study, several conclusions were developed. These conclusions are summarized below.

A. The OWS's are successfully removing TPH from the bilge-water the majority of the time. Although the other tested contaminants are generally found in levels less than the CONMAVBASEPEARLINST 11345.2C discharge limits, the OWS's are not removing significant amounts of them from the bilge-water effluent.

B. TSS is removed from the bilge-water while it is processed through the OWS. The lack of continuous operation and maintenance creates a sludge build-up on the filter panels, and therefore contributes to the inefficiency of the OWS system.

C. The liquid inputs into the bilge-water vary from ship-to-ship and day-to-day. In order to obtain a better picture of the actual inputs, a time sequence study is needed.

D. The oil content monitors did not appear to be consistently working to divert the OWS effluent when it exceeded the discharge limits of 15-ppm.

E. This study further justifies the PWC Pearl Harbor Special Project construction programs for the installation of a sewage piping system from the piers to an OWS/IAF system.

7.2 Recommendations

Based upon the above conclusions, the following recommendations for future actions are made. These recommendations would all require additional testing.

A. Perform additional expanded studies on the OWS effluent to determine the quantities of the contaminants being released into the harbor. If the ships are going to continue to discharge OWS effluent directly into the harbor, the Naval Base should perform more extensive studies on the effluent contents and what is being put into the harbor over longer periods of time. This study was limited by cost to only five samples from four ships. Although it presented a basic idea of the quantities of contaminants in the bilge-water influent and effluent, it could not fully detect any trends that would occur over extended periods of time. Conclusions and assumptions were made in this study based upon the limited data, and could change with further testing.

B. Perform additional studies regarding the maintenance of the OWS, taking into account the lack of regular use of the equipment. The use and maintenance of the OWS's should be further examined to look at the actual extent of the sludge build-up over time. The lack of regular use of the OWS appears to have an effect on the performance of the equipment. Additional studies should be performed, based upon the actual use of the OWS's, to determine how often they should be cleaned and what additional maintenance is required. Once these studies are completed, the information should be evaluated to be consistent with the use patterns of the ships.

C. Perform a time sequence study for the TPH and the TSS to determine how well the OWS's are actually working. This study was very limited in the amount of data that was obtained. In order to obtain a more defined picture of the trends occurring with the influent and the effluent, a time sequence study of the operation of the OWS's should be performed. The study could possibly examine the other contaminants, but at a minimum, it should examine the TPH and the TSS for variances and the relationship between the two constituents.

Tracking the TPH and the TSS inputs over an extended period of time with frequent sampling would show any variances or trends in finer detail. If the outputs were then sampled at time intervals less than the six minute cycle time, any obvious output trends could be identified. These input and output trends could then be overlapped and correlated to determine the effectiveness of the OWS. It could also indicate a relationship between the TPH and the TSS, which could then be used to determine required maintenance intervals.

7.3 Summary

The primary goal of this study was to quantify the levels of the TPH and other contaminants found in bilge-water, and then determine the effectiveness of OWS's in removing these contaminants. The study results showed the amounts of 21 specific contaminants that were present in the bilge-water influent and effluent. The study results also showed that the OWS's were generally not removing the contaminants from the bilge-water,

although this was as expected because of the purely mechanical process of the OWS. When the operation of the OWS was compared to the VTC/DAF operation, the OWS was found to be less efficient at contaminant removal.

The most obvious trends that were noticed during the study involved the TPH and the TSS. The TPH was being removed to less than 15-ppm TPH from the bilge-water effluent by the OWS in 67% of the cases. However, in the remaining 33% of the cases, the TPH exceeded the limit and and was being discharged overboard. The TSS appeared to be decreasing and settling out of the bilge-water while in the OWS. This could have been a factor contributing to the inefficiencies noted with the OWS. Further studies would be needed to determine if a relationship existed between the TPH, TSS and OWS maintenance.

The OCM's were observed and examined during this study. The fact that the TPH effluent values exceeded the discharge limit of 15-ppm indicated that the OCM's could potentially have problems consistently monitoring and maintaining the discharge limits.

The study results showed that the OWS's were removing oil from the effluent, although there were some inefficiencies with the OWS's and the OCM's. However the results supported and justified PWC Pearl Harbor's construction projects involving the installation of a shore based bilge-water treatment system.

Appendix A OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 15 Jun 95

TO: PWC CODE 300A, Attn: LT Rinaldi

TREATABILITY REPORT

Lab No.	95-04592	Date Rcvd	25 May 95
Matrix	Wastewater	Date Sampled	25 May 95
JON	186-8005	ESA No.	N/A
Sample ID	B-00-8-I		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	0.034	0.43	Manganese (Mn)	0.168	—
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.39	3.98
Barium (Ba)	0.121	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	0.090	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.126	2.77	Tin (Sn)	1.93	10
Copper (Cu)	0.65	3.38	Zinc (Zn)	1.25	2.61
Mercury (Hg)	Not Requested	0.05	Mercury was not requested. All other metals analyzed on 26 May 95 by EPA SW-846 Method 6010. Lower detection limits as per request by LT Rinaldi.		
Hexavalent Chromium (Cr^{+6})	—	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.49	5.5-9.5	25 May 95	SW-846 9040
Cyanide	Not Requested	1.2	—	SW-846 9010
Sulfide	<0.5	5	6 Jun 95	HACH
TOC	<10	1200	31 May 95	SM 5310B

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU — DANIEL M. MURANAKA — REGINA S. PRICE

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 15 Jun 95

TO: PWC CODE 300A, LT Rinaldi

MBAS REPORT

Lab No.	95-04592	Date Rcvd	25 May 95
Matrix	Wastewater	Date Sampled	25 May 95
JON	186-8005	ESA No.	N/A
Sample ID	B-00-8-I		

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
MBAS	0.8	30	31 May 95	HACH
TSS	26	600	8 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU DANIEL M. MURANAKA REGINA S. PRICE

NAVY PUBLIC WORKS CENTER
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PEARL HARBOR, HAWAII 96860-5470
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REPORT DATE: 2 Jun 95

TO: Lt. Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-04592	**Date Rcvd**	25 May 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID/ Description	B-00-1-I		

TEST RESULT (TPH, ppm)
7.2

REMARKS:

ANALYST(S):

FERNANDO A. NERONA	ROBERT A. CASTEL	DUANE T. MORITA

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 27 Jun 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04592	**Date Rcvd**	25 May 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID: **Matrix:**	B-00-1-I Wastewater		

Parameter (mg/L)	Results
Chloride	13,200

ANALYST:

Ross M. Morihara

ROSS M. MORIHARA

Appendix A (Continued) OWS LAB REPORTS

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PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 15 Jun 95

TO: PWC CODE 300A, Attn: LT Rinaldi

TREATABILITY REPORT

Lab No.	95-04593	Date Rcvd	25 May 95
Matrix	Wastewater	Date Sampled	25 May 95
JON	186-8005	ESA No.	N/A
Sample ID	B-30-8-I		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	0.047	0.43	Manganese (Mn)	0.166	---
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.44	3.98
Barium (Ba)	0.097	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	0.086	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.164	2.77	Tin (Sn)	1.66	10
Copper (Cu)	0.62	3.38	Zinc (Zn)	1.13	2.61
Mercury (Hg)	Not Requested	0.05	Mercury was not requested. All other metals analyzed on 26 May 95 by EPA SW-846 Method 6010. Lower detection limits as per request by LT Rinaldi.		
Hexavalent Chromium (Cr^{+6})	---	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.48	5.5-9.5	25 May 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	<0.5	5	6 Jun 95	HACH
TOC	<10	1200	31 May 95	SM 5310B

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU DANIEL M. MURANAKA REGINA S. PRICE

Appendix A (Continued)   OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 15 Jun 95

TO: PWC CODE 300A, LT Rinaldi

MBAS REPORT

Lab No.	95-04593	**Date Rcvd**	25 May 95
Matrix	Wastewater	**Date Sampled**	25 May 95
JON	186-8005	**ESA No.**	N/A
Sample ID	B-30-8-I		

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
MBAS	1.3	30	31 May 95	HACH
TSS	49	600	8 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU   DANIEL M. MURANAKA   REGINA S. PRICE

Appendix A (Continued)   OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII   96860-5470
(808) 474-3704

REPORT DATE: 2 Jun 95

TO: Lt. Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-04593	**Date Rcvd**	25 May 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID/ Description	B-30-1-I		

TEST RESULT (TPH, ppm)
7.2

REMARKS:

ANALYST(S):

Fernando A. Nerona — FERNANDO A. NERONA

Robert A. Castel — ROBERT A. CASTEL

DUANE T. MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
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PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 27 Jun 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04593	Date Rcvd	25 May 95
JON	186-8005	ESM/WR No.	N/A
Sample ID: Matrix:	B-30-1-I Wastewater		

Parameter (mg/L)	Results
Chloride	13,200

ANALYST:

Ross M. Morihara

ROSS M. MORIHARA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
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PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 15 Jun 95

TO: PWC CODE 300A, Attn: LT Rinaldi

TREATABILITY REPORT

Lab No.	95-04594	Date Rcvd	25 May 95
Matrix	Wastewater	Date Sampled	25 May 95
JON	186-8005	ESA No.	N/A
Sample ID	B-36-8-O		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	0.059	0.43	Manganese (Mn)	0.172	—
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.36	3.98
Barium (Ba)	0.147	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	0.092	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.157	2.77	Tin (Sn)	1.95	10
Copper (Cu)	0.16	3.38	Zinc (Zn)	0.866	2.61
Mercury (Hg)	Not Requested	0.05	Mercury was not requested. All other metals analyzed on 26 May 95 by EPA SW-846 Method 6010. Lower detection limits as per request by LT Rinaldi.		
Hexavalent Chromium (Cr^{+6})	---	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.57	5.5-9.5	25 May 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	2.3	5	6 Jun 95	SM 4500D
TOC	<10	1200	31 May 95	SM 5310B

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU — DANIEL M. MURANAKA — REGINA S. PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 15 Jun 95

TO: PWC CODE 300A, LT Rinaldi

MBAS REPORT

Lab No.	95-04594	Date Rcvd	25 May 95
Matrix	Wastewater	Date Sampled	25 May 95
JON	186-8005	ESA No.	N/A
Sample ID	B-36-8-O		

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
MBAS	0.9	30	31 May 95	HACH
TSS	20	600	13 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU

Daniel M. Muranaka
DANIEL M. MURANAKA

Regina Price
REGINA S PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
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PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 2 Jun 95

TO: Lt. Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No:	95-04594	Date Rcvd	25 May 95
JON	186-8005	ESM/WR No:	N/A
Sample ID/ Description	B-36-1-0		

TEST RESULT (TPH, ppm)
14

REMARKS:

ANALYST(S):

FERNANDO A. NERONA　　ROBERT A. CASTEL　　DUANE T. MORITA

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 27 Jun 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04594	Date Rcvd	25 May 95
JON	186-8005	ESM/WR No.	N/A
Sample ID: Matrix:	B-36-1-I Wastewater		

Parameter (mg/L)	Results
Chloride	13,100

ANALYST:

Ross M. Morihara

ROSS M. MORIHARA

Appendix A (Continued) OWS LAB REPORTS

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ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 15 Jun 95

TO: PWC CODE 300A, Attn: LT Rinaldi

TREATABILITY REPORT

Lab No.	95-04595	Date Rcvd	25 May 95
Matrix	Wastewater	Date Sampled	25 May 95
JON	186-8005	ESA No.	N/A
Sample ID	B-60-8-I		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	0.059	0.43	Manganese (Mn)	0.176	---
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.45	3.98
Barium (Ba)	0.150	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	0.089	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.167	2.77	Tin (Sn)	2.01	10
Copper (Cu)	0.47	3.38	Zinc (Zn)	1.04	2.61
Mercury (Hg)	Not Requested	0.05	Mercury was not requested. All other metals analyzed on 26 May 95 by EPA SW-846 Method 6010. Lower detection limits as per request by LT Rinaldi.		
Hexavalent Chromium (Cr^{+6})	---	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.53	5.5-9.5	25 May 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	<0.5	5	9 Jun 95	HACH
TOC	<10	1200	31 May 95	SM 5310B

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU DANIEL M. MURANAKA REGINA S. PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
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PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 15 Jun 95

TO: PWC CODE 300A, LT Rinaldi

MBAS REPORT

Lab No.	95-04595	Date Rcvd	25 May 95
Matrix	Wastewater	Date Sampled	25 May 95
JON	186-8005	ESA No.	N/A
Sample ID	B-60-8-I		

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
MBAS	1.0	30	31 May 95	HACH
TSS	46	600	13 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU   DANIEL M. MURANAKA   REGINA S PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
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PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 5 Jun 95

TO: LT. Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-04595	**Date Rcvd**	25 May 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID/ Description	B-60-1-I		

TEST RESULT (TPH, ppm)
9.2

REMARKS:

ANALYST(S):

Fernando A. Nerona — FERNANDO A. NERONA

Robert A. Castel — ROBERT A. CASTEL

DUANE T. MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 27 Jun 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04595	**Date Rcvd**	25 May 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID: **Matrix:**	B-60-1-I Wastewater		

Parameter (mg/L)	Results
Chloride	13,300

ANALYST:

Ross M. Morihara

ROSS M. MORIHARA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 15 Jun 95

TO: PWC CODE 300A, Attn: LT Rinaldi

TREATABILITY REPORT

Lab No.	95-04596	Date Rcvd	25 May 95
Matrix	Wastewater	Date Sampled	25 May 95
JON	186-8005	ESA No.	N/A
Sample ID	B-66-8-O		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	0.077	0.43	Manganese (Mn)	0.176	—
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.39	3.98
Barium (Ba)	0.153	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	0.106	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.193	2.77	Tin (Sn)	1.91	10
Copper (Cu)	0.17	3.38	Zinc (Zn)	0.882	2.61
Mercury (Hg)	Not Requested	0.05	Mercury was not requested. All other metals analyzed on 26 May 95 by EPA SW-846 Method 6010. Lower detection limits as per request by LT Rinaldi.		
Hexavalent Chromium (Cr^{+6})	---	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.58	5.5-9.5	25 May 95	SW-846 9040
Cyanide	Not Requested	1 2	—	SW-846 9010
Sulfide	<0.5	5	9 Jun 95	HACH
TOC	<10	1200	31 May 95	SM 5310B

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU DANIEL M. MURANAKA REGINA S. PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 15 Jun 95

TO: PWC CODE 300A, LT Rinaldi

MBAS REPORT

Lab No.	95-04596	Date Rcvd	25 May 95
Matrix	Wastewater	Date Sampled	25 May 95
JON	186-8005	ESA No.	N/A
Sample ID	B-66-8-O		

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
MBAS	1.0	30	31 May 95	HACH
TSS	21	600	13 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU   DANIEL M. MURANAKA   REGINA S. PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
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PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 2 Jun 95

TO: Lt. Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-04596	Date Rcvd.	25 May 95
JON	186-8005	ESM/WR No.	N/A
Sample ID/ Description	B-66-1-0		

TEST RESULT (TPH, ppm)
8.0

REMARKS:

ANALYST(S):

Robert A. Castel
ROBERT A. CASTEL

Duane T. Morita
DUANE T. MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 27 Jun 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04596	Date Rcvd	25 May 95
JON	186-8005	ESM/WR No.	N/A
Sample ID: Matrix:	B-66-1-I Wastewater		

Parameter (mg/L)	Results
Chloride	13,100

ANALYST:

Ross M. Morihara

ROSS M. MORIHARA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 22 Jun 95

TO: PWC CODE 300A, Attn: Lt. Rinaldi

TREATABILITY REPORT

Lab No.	95-04939	Date Rcvd	08 Jun 95
Matrix	Wastewater	Date Sampled	08 Jun 95
JON	186-8005	ESA No.	N/A
Sample ID	C-00-8-I		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	<0.033	0.43	Manganese (Mn)	0.130	---
Arsenic (As)	<0.30	0.5	Nickel (Ni)	2.27	3.98
Barium (Ba)	0.037	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	0.057	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.051	2.77	Tin (Sn)	2.07	10
Copper (Cu)	2.40	3.38	Zinc (Zn)	4.33	2.61
Mercury (Hg)	Not Requested	0.05	Metals analyzed on 13 Jun 95 by EPA SW-846 Method 6010. Lower detection levels as per request by Lt. Rinaldi		
Hexavalent Chromium (Cr^{+6})	---	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.33	5.5-9.5	13 Jun 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	<0.5	5	08 Jun 95	HACH
TOC	20	1200	16 Jun 95	SM 5310B
MBAS, ppm	0.2	30	13 Jun 95	HACH
TSS, ppm	55	600	13 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU   DANIEL M. MURANAKA   REGINA S. PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
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PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 10 Jun 95

TO: LT RINALDI

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-04939	Date Rcvd	08 Jun 95
JON	186-8005	ESM/WR No.	N/A
Sample ID/ Description	WASTEWATER, C-00-1-I		

TEST RESULT (TPH, ppm)
91

ANALYST(S):

FERNANDO A. NERONA   ROBERT A. CASTEL   DUANE T. MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 10 Apr 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04939	Date Rcvd	8 Jun 95
JON	186-8005	ESM/WR No.	N/A
Sample ID: Matrix:	C-00-8-I Wastewater		

Parameter (mg/L)	Results
Chloride	12,000

ANALYST:

Ross M. Morihara

ROSS M. MORIHARA

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 22 Jun 95

TO: PWC CODE 300A, Attn: Lt. Rinaldi

TREATABILITY REPORT

Lab No.	95-04940	Date Rcvd	08 Jun 95
Matrix	Wastewater	Date Sampled	08 Jun 95
JON	186-8005	ESA No.	N/A
Sample ID	C-30-8-I		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	<0.033	0.43	Manganese (Mn)	0.132	---
Arsenic (As)	<0.30	0.5	Nickel (Ni)	2.22	3.98
Barium (Ba)	0.037	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	0.071	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.047	2.77	Tin (Sn)	2.17	10
Copper (Cu)	2.03	3.38	Zinc (Zn)	4.52	2.61
Mercury (Hg)	Not Requested	0.05	Metals analyzed on 13 Jun 95 by EPA SW-846 Method 6010. Lower detection levels as per request by Lt. Rinaldi.		
Hexavalent Chromium (Cr^{+6})	—	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.27	5.5-9.5	13 Jun 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	<0.5	5	08 Jun 95	HACH
TOC	13	1200	16 Jun 95	SM 5310B
MBAS, ppm	0.2	30	13 Jun 95	HACH
TSS, ppm	46	600	13 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU

DANIEL M. MURANAKA

REGINA S. PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
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PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 23 Jun 95

TO: Lt. Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-04940	Date Rcvd	08 Jun 95
JON	186-8005	ESM/WR No.	N/A
Sample ID/ Description	C-30-1-I		

TEST RESULT (TPH, ppm)
47.0

REMARKS:

ANALYST(S):

FERNANDO A. NERONA

DUANE T. MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 10 Apr 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04940	Date Rcvd	8 Jun 95
JON	186-8005	ESM/WR No.	N/A
Sample ID: Matrix:	C-30-8-I Wastewater		

Parameter (mg/L)	Results
Chloride	12,200

ANALYST:

ROSS M. MORIHARA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 22 Jun 95

TO: PWC CODE 300A, Attn: Lt. Rinaldi

TREATABILITY REPORT

Lab No.	95-04941	Date Rcvd	08 Jun 95
Matrix	Wastewater	Date Sampled	08 Jun 95
JON	186-8005	ESA No.	N/A
Sample ID	C-36-8-0		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	<0.033	0.43	Manganese (Mn)	0.234	—
Arsenic (As)	<0.30	0.5	Nickel (Ni)	11.3	3.98
Barium (Ba)	0.038	50	Lead (Pb)	0.34	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	<0.033	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.057	2.77	Tin (Sn)	2.33	10
Copper (Cu)	8.38	3.38	Zinc (Zn)	6.38	2.61
Mercury (Hg)	Not Requested	0.05	Metals analyzed on 13 Jun 95 by EPA SW-846 Method 6010. Lower detection levels as per request by Lt. Rinaldi.		
Hexavalent Chromium (Cr^{+6})	—	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.31	5.5-9.5	13 Jun 95	SW-846 9040
Cyanide	Not Requested	1.2	—	SW-846 9010
Sulfide	<0.5	5	08 Jun 95	HACH
TOC	<10	1200	16 Jun 95	SM 5310B
MBAS, ppm	0.2	30	13 Jun 95	HACH
TSS, ppm	25	600	13 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

for RANDALL K. TAKAESU   DANIEL M. MURANAKA   REGINA S. PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 10 Jun 95

TO: LT RINALDI

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-04941	Date Rcvd	08 Jun 95
JON	186-8005	ESM/WR No.	N/A
Sample ID/ Description	WASTEWATER, C-36-1-O		

TEST RESULT (TPH, ppm)
14

ANALYST(S):

FERNANDO A. NERONA   ROBERT A. CASTEL   DUANE T. MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 10 Apr 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04941	**Date Rcvd**	8 Jun 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID: **Matrix:**	C-36-8-O Wastewater		

Parameter (mg/L)	Results
Chloride	12,400

ANALYST:

ROSS M. MORIHARA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 22 Jun 95

TO: PWC CODE 300A, Attn: Lt. Rinaldi

TREATABILITY REPORT

Lab No.	95-04942	Date Rcvd	08 Jun 95
Matrix	Wastewater	Date Sampled	08 Jun 95
JON	186-8005	ESA No.	N/A
Sample ID	C-60-8-I		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	<0.033	0.43	Manganese (Mn)	0.141	---
Arsenic (As)	<0.30	0.5	Nickel (Ni)	2.36	3.98
Barium (Ba)	0.040	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	0.068	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.063	2.77	Tin (Sn)	1.80	10
Copper (Cu)	3.30	3.38	Zinc (Zn)	4.88	2.61
Mercury (Hg)	Not Requested	0.05	Metals analyzed on 13 Jun 95 by EPA SW-846 Method 6010. Lower detection levels as per request by Lt. Rinaldi.		
Hexavalent Chromium (Cr^{+6})	—	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.31	5.5-9.5	13 Jun 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-845 9010
Sulfide	<0.5	5	08 Jun 95	HACH
TOC	<10	1200	16 Jun 95	SM 5310B
MBAS, ppm	0.2	30	13 Jun 95	HACH
TSS, ppm	45	600	13 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU DANIEL M. MURANAKA REGINA S. PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: **10 Jun 95**

TO: LT RINALDI

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-04942	**Date Rcvd**	08 Jun 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID/ Description	WASTEWATER, C-60-1-I		

TEST RESULT (TPH, ppm)
70

ANALYST(S):

FERNANDO A. NERONA　　ROBERT A. CASTEL　　DUANE T. MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 10 Apr 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04942	**Date Rcvd**	**8 Jun 95**
JON	186-8005	**ESM/WR No.**	**N/A**
Sample ID: **Matrix:**	C-60-8-I Wastewater		

Parameter (mg/L)	Results
Chloride	12,200

ANALYST:

Ross M. Morihara

ROSS M. MORIHARA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 22 Jun 95

TO: PWC CODE 300A, Attn: Lt. Rinaldi

TREATABILITY REPORT

Lab No.	95-04943	Date Rcvd	08 Jun 95
Matrix	Wastewater	Date Sampled	08 Jun 95
JON	186-8005	ESA No.	N/A
Sample ID	C-66-8-0		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	<0.033	0.43	Manganese (Mn)	0.161	---
Arsenic (As)	<0.30	0.5	Nickel (Ni)	2.90	3.98
Barium (Ba)	0.041	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	0.079	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.091	2.77	Tin (Sn)	1.65	10
Copper (Cu)	2.47	3.38	Zinc (Zn)	4.43	2.61
Mercury (Hg)	Not Requested	0.05	Metals analyzed on 13 Jun 95 by EPA SW-846 Method 6010. Lower detection levels as per request by Lt. Rinaldi.		
Hexavalent Chromium (Cr^{+6})	---	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.43	5.5-9.5	13 Jun 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	<0.5	5	08 Jun 95	HACH
TOC	<10	1200	16 Jun 95	SM 5310B
MBAS, ppm	0.1	30	13 Jun 95	HACH
TSS, ppm	21	600	13 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU DANIEL M. MURANAKA REGINA S. PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 23 Jun 95

TO: Lt. Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No	95-04943	Date Rcvd	08 Jun 95
JON	186-8005	ESM/WR No.	N/A
Sample ID/ Description	C-66-1-O		

TEST RESULT (TPH, ppm)
10.3

REMARKS:

ANALYST(S):

f/r FERNANDO A. NERONA

DUANE T MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 10 Apr 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04943	Date Rcvd	8 Jun 95
JON	186-8005	ESM/WR No.	N/A
Sample ID: Matrix:	C-66-8-O Wastewater		

Parameter (mg/L)	Results
Chloride	12,400

ANALYST:

ROSS M. MORIHARA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 23 Jun 95

TO: PWC CODE 300A, Attn: Lt. Rinaldi

TREATABILITY REPORT

Lab No.	95-04947	Date Rcvd	09 Jun 95
Matrix	Wastewater	Date Sampled	09 Jun 95
JON	186-8005	ESA No.	N/A
Sample ID	D-00-8-I		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	<0.033	0.43	Manganese (Mn)	0.269	—
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.49	3.98
Barium (Ba)	0.332	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	0.038	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.059	2.77	Tin (Sn)	<1.20	10
Copper (Cu)	0.36	3.38	Zinc (Zn)	0.425	2.61
Mercury (Hg)	Not Requested	0.05	Metals analyzed on 13 Jun 95 by EPA SW-846 Method 6010. Lower detection levels as per request by Lt. Rinaldi.		
Hexavalent Chromium (Cr^{+6})	---	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.33	5.5-9.5	13 Jun 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	70	5	13 Jun 95	SM 4500D
TOC	138	1200	16 Jun 95	SM 5310B
MBAS, ppm	0.2	30	13 Jun 95	HACH
TSS, ppm	126	600	13 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU DANIEL M. MURANAKA REGINA S. PRICE

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 23 Jun 95

TO: Lt. Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-04947	Date Rcvd	09 Jun 95
JON	186-8005	ESM/WR No.	N/A
Sample ID/ Description	D-00-1-I		

TEST RESULT (TPH, ppm)
1690

REMARKS:

ANALYST(S):

For FERNANDO A. NERONA

DUANE T. MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 10 Apr 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04947	Date Rcvd	9 Jun 95
JON	186-8005	ESM/WR No.	N/A
Sample ID: Matrix:	D-00-8-I Wastewater		

Parameter (mg/L)	Results
Chloride	5,400

ANALYST:

ROSS M. MORIHARA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 23 Jun 95

TO: PWC CODE 300A, Attn: Lt. Rinaldi

TREATABILITY REPORT

Lab No.	95-04948	Date Rcvd	09 Jun 95
Matrix	Wastewater	Date Sampled	09 Jun 95
JON	186-8005	ESA No.	N/A
Sample ID	D-30-8-I		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	<0.033	0.43	Manganese (Mn)	0.302	---
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.48	3.98
Barium (Ba)	0.417	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	<0.033	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.062	2.77	Tin (Sn)	<1.20	10
Copper (Cu)	0.39	3.38	Zinc (Zn)	0.190	2.61
Mercury (Hg)	Not Requested	0.05	Metals analyzed on 13 Jun 95 by EPA SW-846 Method 6010. Lower detection levels as per request by Lt. Rinaldi.		
Hexavalent Chromium (Cr^{+6})	---	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.23	5.5-9.5	13 Jun 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	65	5	13 Jun 95	SM 4500D
TOC	65	1200	16 Jun 95	SM 5310B
MBAS, ppm	0.2	30	13 Jun 95	HACH
TSS, ppm	28	600	13 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

FOR RANDALL K. TAKAESU

DANIEL M. MURANAKA

REGINA S. PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 23 Jun 95

TO: Lt. Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-04948	**Date Rcvd**	09 Jun 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID/ Description	D-30-1-I		

TEST RESULT (TPH, ppm)
79.1

REMARKS:

ANALYST(S):

for FERNANDO A. NERONA

DUANE T. MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 10 Apr 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04948	**Date Rcvd**	9 Jun 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID: **Matrix:**	D-30-8-I Wastewater		

Parameter (mg/L)	Results
Chloride	4,000

ANALYST:

ROSS M. MORIHARA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 23 Jun 95

TO: PWC CODE 300A, Attn: Lt. Rinaldi

TREATABILITY REPORT

Lab No.	95-04949	Date Rcvd	09 Jun 95
Matrix	Wastewater	Date Sampled	09 Jun 95
JON	186-8005	ESA No.	N/A
Sample ID	D-36-8-O		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	<0.033	0.43	Manganese (Mn)	0.289	---
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.52	3.98
Barium (Ba)	0.432	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	<0.033	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.069	2.77	Tin (Sn)	1.28	10
Copper (Cu)	0.35	3.38	Zinc (Zn)	0.242	2.61
Mercury (Hg)	Not Requested	0.05	Metals analyzed on 13 Jun 95 by EPA SW-846 Method 6010. Lower detection levels as per request by Lt. Rinaldi.		
Hexavalent Chromium (Cr^{+6})	---	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.25	5.5-9.5	13 Jun 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	59	5	13 Jun 95	SM 4500D
TOC	70	1200	16 Jun 95	SM 5310B
MBAS, ppm	0.2	30	13 Jun 95	HACH
TSS, ppm	17	600	13 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU DANIEL M. MURANAKA REGINA S. PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 23 Jun 95

TO: Lt. Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-04949	Date Rcvd.	09 Jun 95
JON	186-8005	ESM/WR No.	N/A
Sample ID/ Description	D-36-1-O		

TEST RESULT (TPH, ppm)
19.2

REMARKS:

ANALYST(S):

for FERNANDO A. NERONA

DUANE T. MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 10 Apr 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04949	**Date Rcvd**	9 Jun 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID: **Matrix:**	D-36-8-O Wastewater		

Parameter (mg/L)	Results
Chloride	4,000

ANALYST:

Ross M. Morihara

ROSS M. MORIHARA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 23 Jun 95

TO: PWC CODE 300A, Attn: Lt. Rinaldi

TREATABILITY REPORT

Lab No.	95-04950	Date Rcvd	09 Jun 95
Matrix	Wastewater	Date Sampled	09 Jun 95
JON	186-8005	ESA No.	N/A
Sample ID	D-60-8-I		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	<0.033	0.43	Manganese (Mn)	0.188	---
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.41	3.98
Barium (Ba)	0.273	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	<0.033	0.69	Thallium (Tl)	<0 38	0.5
Chromium (Cr)	0.045	2.77	Tin (Sn)	<1 20	10
Copper (Cu)	0.64	3.38	Zinc (Zn)	0.395	2.61
Mercury (Hg)	Not Requested	0.05	Metals analyzed on 13 Jun 95 by EPA SW-846 Method 6010. Lower detection levels as per request by Lt. Rinaldi.		
Hexavalent Chromium (Cr^{+6})	---	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	6.94	5.5-9.5	13 Jun 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	31	5	13 Jun 95	SM 4500D
TOC	48	1200	16 Jun 95	SM 5310B
MBAS, ppm	<0.1	30	13 Jun 95	HACH
TSS, ppm	20	600	13 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU DANIEL M. MURANAKA REGINA S. P[illegible]

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 23 Jun 95

TO: Lt. Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-04950	Date Rcvd	09 Jun 95
JON	186-8005	ESM/WR No.	N/A
Sample ID/ Description	D-60-1-I		

TEST RESULT (TPH, ppm)
31.5

REMARKS:

ANALYST(S):

For FERNANDO A. NERONA

DUANE T. MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 10 Apr 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04950	**Date Rcvd**	9 Jun 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID: **Matrix:**	D-60-8-I Wastewater		

Parameter (mg/L)	Results
Chloride	2,000

ANALYST:

Ross M. Morihara

ROSS M. MORIHARA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 23 Jun 95

TO: PWC CODE 300A, Attn: Lt. Rinaldi

TREATABILITY REPORT

Lab No.	95-04951	Date Rcvd	09 Jun 95
Matrix	Wastewater	Date Sampled	09 Jun 95
JON	186-8005	ESA No.	N/A
Sample ID	D-66-8-O		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	<0.033	0.43	Manganese (Mn)	0.206	---
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.43	3.98
Barium (Ba)	0.311	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	<0.033	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.060	2.77	Tin (Sn)	<1.20	10
Copper (Cu)	0.59	3.38	Zinc (Zn)	0.556	2.61
Mercury (Hg)	Not Requested	0.05	Metals analyzed on 13 Jun 95 by EPA SW-846 Method 6010. Lower detection levels as per request by Lt. Rinaldi.		
Hexavalent Chromium (Cr^{+6})	—	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	6.74	5.5-9.5	13 Jun 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	31	5	13 Jun 95	SM 4500D
TOC	35	1200	16 Jun 95	SM 5310B
MBAS, ppm	0.2	30	13 Jun 95	HACH
TSS, ppm	13	600	13 Jun 95	SM 2540D

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU   DANIEL M. MURANAKA   REGINA S. PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 23 Jun 95

TO: Lt. Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-04951	**Date Rcvd**	09 Jun 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID/ Description	D-66-1-O		

TEST RESULT (TPH, ppm)
13.9

REMARKS:

ANALYST(S):

fw. FERNANDO A. NERONA

DUANE T. MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 10 Apr 95

TO: PWC CODE 300A, LT Rinaldi

CHLORIDE REPORT

Lab No.	95-04951	Date Rcvd	9 Jun 95
JON	186-8005	ESM/WR No.	N/A
Sample ID: Matrix:	D-66-8-O Wastewater		

Parameter (mg/L)	Results
Chloride	2,200

ANALYST:

Ross M. Morihara

ROSS M. MORIHARA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

*** AMENDED REPORT ***

REPORT DATE: 20 Apr 95

TO: PWC CODE 300A, Attn: LT Rinaldi

TREATABILITY REPORT

Lab No.	95-02569	Date Rcvd	3 Apr 95
Matrix	Wastewater	Date Sampled	3 Apr 95
JON	186-8005	ESA No.	N/A
Sample ID	T-00-8-I		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	<0.033	0.43	Manganese (Mn)	0.225	—
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.57	3.98
Barium (Ba)	0.095	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0 2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	0.063	0.69	Thallium (Tl)	<0 38	0.5
Chromium (Cr)	0.093	2.77	Tin (Sn)	<1.20	10
Copper (Cu)	0.24	3.38	Zinc (Zn)	1.61	2.61
Mercury (Hg)	—	0.05	Mercury was not requested. All other metals analyzed on 10 Apr 95 by EPA SW-846 Method 6010. Lower detection levels as per request by LT Rinaldi, 12 Jun 95.		
Hexavalent Chromium (Cr^{+6})	Not Required	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.13	5.5-9.5	4 Apr 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	<0.5	5	4 Apr 95	HACH
TOC	17	1200	4 Apr 95	SM 5310B

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU | DANIEL M. MURANAKA | REGINA S. PRICE

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 20 Apr 95

TO: PWC CODE 300A, Attn: LT Rinaldi

GENERAL CHEMISTRY REPORT

Lab No.	95-02569	Date Rcvd	3 Apr 95
Matrix	Wastewater	Date Sampled	3 Apr 95
JON	186-8005	ESA No.	N/A
Sample ID	T-00-8-I		

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
TSS	32	600	4 Apr 95	SM 2540D
MBAS	0.2	30	6 Apr 95	HACH

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

STEVEN L. LYELL

DANIEL M. MURANAKA

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 5 Apr 95

TO: PWC CODE 300A, Attn: Lt. Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-02569	Date Rcvd	03 Apr 95
JON	186-8005	ESM/WR No.	N/A
Sample ID/ Description	T-00-1-I		

TEST RESULT (TPH, ppm)
300

REMARKS:

ANALYST(S):

FERNANDO A. NERONA   ROBERT A. CASTEL   MARK K. ARAKAKI

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 09 May 95

TO: LT. RINALDI

CHLORIDE REPORT

Lab No.	95-02569	Date Rcvd	3 Apr 95
JON	186-8005	ESM/WR No.	N/A
Sample ID: Matrix:	T-00-8-I WASTEWATER		

Method: SM 18th Ed 4500-CIC Chloride, ppm Results
5900

REMARKS

ANALYST:

VERNON G.W. KAM

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

*** AMENDED REPORT ***

REPORT DATE: 15 Jun 95

TO: PWC CODE 300A, Attn: LT Rinaldi

TREATABILITY REPORT

Lab No.	95-02570	Date Rcvd	3 Apr 95
Matrix	Wastewater	Date Sampled	3 Apr 95
JON	186-8005	ESA No.	N/A
Sample ID	T-30-8-I		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	<0.033	0.43	Manganese (Mn)	0.122	---
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.45	3.98
Barium (Ba)	0.082	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	0.036	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.051	2.77	Tin (Sn)	<1.20	10
Copper (Cu)	<0.13	3.38	Zinc (Zn)	0.537	2.61
Mercury (Hg)	---	0.05	Mercury was not requested. All other metals analyzed on 10 Apr 95 by EPA SW-846 Method 6010. Lower detection levels as per request by LT Rinaldi, 12 Jun 95.		
Hexavalent Chromium (Cr^{+6})	Not Required	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	6.84	5.5-9.5	4 Apr 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	<0.5	5	4 Apr 95	HACH
TOC	29	1200	4 Apr 95	SM 5310B

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K TAKAESU

DANIEL M. MURANAKA

REGINA S PRICE

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 20 Apr 95

TO: PWC CODE 300A, Attn: LT Rinaldi

GENERAL CHEMISTRY REPORT

Lab No.	95-02570	Date Rcvd	3 Apr 95
Matrix	Wastewater	Date Sampled	3 Apr 95
JON	186-8005	ESA No.	N/A
Sample ID	T-30-8-I		

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
TSS	12	600	4 Apr 95	SM 2540D
MBAS	0.2	30	6 Apr 95	HACH

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

STEVEN L. LYELL

DANIEL M. MURANAKA

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 5 Apr 95

TO: PWC CODE 300A, Attn: Lt. Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-02570	Date Rcvd	03 Apr 95
JON	186-8005	ESM/WR No.	N/A
Sample ID/ Description	T-30-1-I		

TEST RESULT (TPH, ppm)
33

REMARKS:

ANALYST(S):

FERNANDO A. NERONA	ROBERT A. CASTEL	MARK K. ARAKAKI

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 09 May 95

TO: LT. RINALDI

CHLORIDE REPORT

Lab No.:	95-02570	**Date Rcvd:**	3 Apr 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID: **Matrix:**	T-30-8-I WASTEWATER		

Method: SM 18th Ed 4500-CIC Chloride, ppm Results
3500

REMARKS:

ANALYST:

Vernon G.W. Kam

VERNON G.W. KAM

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

*** AMENDED REPORT ***

REPORT DATE: 15 Jun 95

TO: PWC CODE 300A, Attn: LT Rinaldi

TREATABILITY REPORT

Lab No.	95-02571	Date Rcvd	3 Apr 95
Matrix	Wastewater	Date Sampled	3 Apr 95
JON	186-8005	ESA No.	N/A
Sample ID	T-36-8-O		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	<0.033	0.43	Manganese (Mn)	0.139	---
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.61	3.98
Barium (Ba)	0.085	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	<0.033	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.074	2.77	Tin (Sn)	<1.20	10
Copper (Cu)	0.36	3.38	Zinc (Zn)	0.764	2.61
Mercury (Hg)	---	0.05	Mercury was not requested. All other metals analyzed on 10 Apr 95 by EPA SW-846 Method 6010. Lower detection levels as per request by LT Rinaldi, 12 Jun 95.		
Hexavalent Chromium (Cr^{+6})	Not Required	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	6.94	5.5-9.5	4 Apr 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	<0.5	5	4 Apr 95	HACH
TOC	27	1200	4 Apr 95	SM 5310B

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU | DANIEL M. MURANAKA | REGINA S. PRICE

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 20 Apr 95

TO: PWC CODE 300A, Attn: LT Rinaldi

GENERAL CHEMISTRY REPORT

Lab No.	95-02571	Date Rcvd	3 Apr 95
Matrix	Wastewater	Date Sampled	3 Apr 95
JON	186-8005	ESA No.	N/A
Sample ID	T-36-8-O		

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
TSS	12	600	4 Apr 95	SM 2540D
MBAS	0.2	30	6 Apr 95	HACH

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

STEVEN L. LYELL

DANIEL M. MURANAKA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 10 Apr 95

TO: LT. RINALDI

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-02571	Date Rcvd	3 Apr 95
JON	186-8005	ESM/WR No.	N/A
Sample ID/ Description	T-36-1-0		

TEST RESULT (TPH, ppm)
55

REMARKS:

ANALYST(S):

FERNANDO A. NERONA   ROBERT A. CASTEL   DUANE T. MORITA

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 09 May 95

TO: LT. RINALDI

CHLORIDE REPORT

Lab No:	95-02571	Date Rcvd	3 Apr 95
JON:	186-8005	ESM/WR No:	N/A
Sample ID: Matrix:	T-36-8-I WASTEWATER		

Method: SM 18th Ed 4500-ClC Chloride, ppm Results
3600

REMARKS:

ANALYST:

Vernon G.W. Kam

VERNON G.W. KAM

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

*** AMENDED REPORT ***

REPORT DATE: 15 Jun 95

TO: PWC CODE 300A, Attn: LT Rinaldi

TREATABILITY REPORT

Lab No.	95-02572	Date Rcvd	3 Apr 95
Matrix	Wastewater	Date Sampled	3 Apr 95
JON	186-8005	ESA No.	N/A
Sample ID	T-60-8-I		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	<0.033	0.43	Manganese (Mn)	0.152	---
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.40	3.98
Barium (Ba)	0.053	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	0.059	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.092	2.77	Tin (Sn)	<1.20	10
Copper (Cu)	<0.13	3.38	Zinc (Zn)	0.306	2.61
Mercury (Hg)	---	0.05	Mercury was not requested. All other metals analyzed on 10 Apr 95 by EPA SW-846 Method 6010. Lower detection levels as per request by LT Rinaldi, 12 Jun 95.		
Hexavalent Chromium (Cr^{+6})	Not Required	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.04	5.5-9.5	4 Apr 95	SW-846 9040
Cyanide	Not Requested	1.2	—	SW-846 9010
Sulfide	<0.5	5	4 Apr 95	HACH
TOC	32	1200	4 Apr 95	SM 5310B

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU

DANIEL M. MURANAKA

REGINA S PRICE

NAVY PUBLIC WORKS CENTER
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PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 20 Apr 95

TO: PWC CODE 300A, Attn: LT Rinaldi

GENERAL CHEMISTRY REPORT

Lab No.	95-02572	Date Rcvd	3 Apr 95
Matrix	Wastewater	Date Sampled	3 Apr 95
JON	186-8005	ESA No.	N/A
Sample ID	T-60-8-I		

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
TSS	52	600	4 Apr 95	SM 2540D
MBAS	0.5	30	6 Apr 95	HACH

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

STEVEN L. LYELL

DANIEL M. MURANAKA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 7 Apr 95

TO: PWC CODE 300A, Attn: LT Rinaldi

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-02572	**Date Rcvd**	3 Apr 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID/ Description	T-60-1-I Wastewater		

TEST RESULT (TPH, ppm)
110

ANALYST(S):

ROBERT A. CASTEL   DUANE T. MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 09 May 95

TO: LT. RINALDI

CHLORIDE REPORT

Lab No.	95-02572	Date Rcvd:	3 Apr 95
JON	186-8005	ESM/WR No.	N/A
Sample ID: Matrix:	T-60-8-I WASTEWATER		

Method: SM 18thEd 4500-ClC Chloride, ppm Results
4200

REMARKS:

ANALYST:

Vernon G.W. Kam
VERNON G.W. KAM

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

*** AMENDED REPORT ***

REPORT DATE: 15 Jun 95

TO: PWC CODE 300A, Attn: LT Rinaldi

TREATABILITY REPORT

Lab No.	95-02573	Date Rcvd	3 Apr 95
Matrix	Wastewater	Date Sampled	3 Apr 95
JON	186-8005	ESA No.	N/A
Sample ID	T-66-8-O		

TOTAL METALS

Parameter	Results, ppm	Limit, ppm	Parameter	Results, ppm	Limit, ppm
Silver (Ag)	0.033	0.43	Manganese (Mn)	0.170	---
Arsenic (As)	<0.30	0.5	Nickel (Ni)	0.47	3.98
Barium (Ba)	0.068	50	Lead (Pb)	<0.30	0.69
Beryllium (Be)	<0.007	0.2	Selenium (Se)	<0.47	0.9
Cadmium (Cd)	0.043	0.69	Thallium (Tl)	<0.38	0.5
Chromium (Cr)	0.098	2.77	Tin (Sn)	<1.20	10
Copper (Cu)	0.18	3.38	Zinc (Zn)	0.819	2.61
Mercury (Hg)	---	0.05	Mercury was not requested. All other metals analyzed on 10 Apr 95 by EPA SW-846 Method 6010. Lower detection levels as per request by LT Rinaldi, 12 Jun 95.		
Hexavalent Chromium (Cr^{+6})	Not Required	0.5			

GENERAL CHEMISTRY

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
pH	7.15	5.5-9.5	4 Apr 95	SW-846 9040
Cyanide	Not Requested	1.2	---	SW-846 9010
Sulfide	<0.5	5	4 Apr 95	HACH
TOC	25	1200	4 Apr 95	SM 5310B

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

RANDALL K. TAKAESU — DANIEL M. MURANAKA — REGINA S. PRICE

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 20 Apr 95

TO: PWC CODE 300A, Attn: LT Rinaldi

GENERAL CHEMISTRY REPORT

Lab No:	95-02573	Date Rcvd:	3 Apr 95
Matrix:	Wastewater	Date Sampled:	3 Apr 95
JON:	186-8005	ESA No:	N/A
Sample ID	T-66-8-O		

Parameter	Results, ppm	Limit, ppm	Date Analyzed	Method
TSS	24	600	4 Apr 95	SM 2540D
MBAS	0.6	30	6 Apr 95	HACH

Limits published in COMNAVBASEPEARLINST 11345.2C

ANALYSTS:

STEVEN L. LYELL

DANIEL M. MURANAKA

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

REPORT DATE: 10 Apr 95

TO: LT. RINALDI

TOTAL PETROLEUM HYDROCARBONS REPORT

Lab No.	95-02573	Date Rcvd	3 Apr 95
JON	186-8005	ESM/WR No.	N/A
Sample ID/ Description	T-66-1-0		

TEST RESULT (TPH, ppm)
29

REMARKS:

ANALYST(S):

FERNANDO A. NERONA

DUANE T. MORITA

Appendix A (Continued) OWS LAB REPORTS

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL LABORATORY
PEARL HARBOR, HAWAII 96860-5470
(808) 474-3704

Report Date: 09 May 95

TO: LT. RINALDI

CHLORIDE REPORT

Lab No.	95-02573	**Date Rcvd**	3 Apr 95
JON	186-8005	**ESM/WR No.**	N/A
Sample ID: **Matrix:**	T-66-8-I WASTEWATER		

Method: SM 18th Ed 4500-ClC **Chloride, ppm** **Results**
4150

REMARKS:

ANALYST:

VERNON G.W. KAM

Appendix B NAVY-WIDE BILGE-WATER CHARACTERIZATION STUDY CONTAMINANT VALUES

Number of	Contaminant Values (ppm)				
Samples	Arsenic	Barium	Beryllium	Cadmium	Chromium
1	0.1	2	0.1	0.28	0.77
2	0.1	1	0.1	0.178	0.77
3	0.006	0.17	0.005	0.156	0.23
4	0.028	0.122	0.005	0.1	0.2
5	0.018	0.115	0.005	0.1	0.19
6	0.01	0.100	0.005	0.1	0.13
7	0.008	0.094	0.005	0.082	0.1
8	0.007	0.092	0.005	0.067	0.1
9	0.006	0.06	0.005	0.05	0.05
10	0.005	0.059	0.005	0.044	0.05
11	0.004	0.057	0.0003	0.037	0.07
12	0.004	0.048	0.0002	0.033	0.04
13	0.004	0.042	0.0002	0.03	0.03
14	0.004	.0.04	0.0002	0.029	0.03
15	0.003	0.034	0.0002	0.024	0.03
16	0.003	0.03	0.0002	0.02	0.02
17	0.002	0.02	0.0002	0.02	0.01
18	0.001	0.001	0.0002	0.02	0.01
19				0.02	0.01
20				0.017	0.01
21				0.011	0.01
22				0.01	0.01
23				0.01	0.01
24				0.01	0.01
25				0.01	0.01
26				0.01	0.01
27				0.01	0.01
28				0.01	0.01
29				0.01	0.01
30				0.01	0.01
31				0.01	0.01
32				0.01	0.01
33				0.01	0.01
34				0.01	0.01
35				0.01	0.01
36				0.01	0.01
37				0.01	0.01
38				0.01	0.01
39				0.01	0.01
40				0.01	0.01
41				0.01	0.01
42				0.01	0.01
43				0.009	0.01
44				0.005	0.01
45				0.003	0.01
46				0.003	0.01

Appendix B (Continued) NAVY-WIDE BILGE-WATER CHARACTERIZATION STUDY CONTAMINANT VALUES

Number of	Contaminant Values (ppm)				
Samples	Copper	Lead	Manganese	MBAS	Nickel
1	6.4	2.9	3	77	3.5
2	5.32	0.58	1.35	15	2.63
3	2.93	0.53	1.16	2.5	1.59
4	2.5	0.51	1.15	2.1	1
5	2.45	0.4	1.12	1.5	0.89
6	2.2	0.3	0.96	1.5	0.65
7	2.06	0.3	0.833	0.99	0.55
8	1.72	0.27	0.4	0.91	0.44
9	1.45	0.27	0.37	0.78	0.41
10	1.18	0.25	0.269	0.6	0.31
11	1.1	0.23	0.26	0.59	0.29
12	1	0.2	0.25	0.53	0.28
13	0.88	0.18	0.23	0.52	0.26
14	0.85	0.13	0.22	0.47	0.25
15	0.83	0.12	0.21	0.44	0.23
16	0.77	0.09	0.16	0.44	0.18
17	0.76	0.06	0.14	0.37	0.15
18	0.73	0.05	0.14	0.35	0.12
19	0.71	0.05	0.13	0.35	0.1
20	0.7	0.05	0.12	0.31	0.06
21	0.56	0.05	0.11	0.26	0.05
22	0.56	0.04	0.11	0.24	0.04
23	0.52	0.04	0.11	0.228	0.02
24	0.49	0.03	0.11	0.214	0.01
25	0.43	0.03	0.11	0.19	0.01
26	0.38	0.03	0.11	0.17	0.01
27	0.37	0.02	0.1	0.1	0.01
28	0.32	0.02	0.1	0.07	0.01
29	0.32	0.02	0.09		0.01
30	0.23	0.01	0.09		0.01
31	0.21	0.01	0.08		0.01
32	0.2	0.01	0.08		0.01
33	0.18	0.01	0.07		0.01
34	0.17	0.01	0.07		0.01
35	0.16	0.01	0.07		0.01
36	0.13	0.01	0.07		0.01
37	0.12	0.01	0.051		0.01
38	0.12	0.01	0.05		0.01
39	0.08	0.01	0.05		0.01
40	0.08	0.01	0.04		0.01
41	0.05	0.01	0.04		0.01
42	0.01	0.01	0.03		0.01
43	0.01	0.01	0.02		0.01
44	0.01	0.01	0.01		0.01
45	0.01	0.01	0.01		0.01
46	0.01	0.01	0.01		0.01

Appendix B (Continued) NAVY-WIDE BILGE-WATER CHARACTERIZATION STUDY CONTAMINANT VALUES

Number of	Contaminant Values (ppm)				
Samples	pH	Selenium	Silver	Sulfide	Thallium
1	7.9	0.20	0.1	0.5	0.2
2	7.79	0.1	0.1	0.5	0.2
3	7.64	0.1	0.08		0.1
4	7.6	0.04	0.05		0.1
5	7.57	0.03	0.01		0.1
6	7.57	0.03	0.01		0.1
7	7.43	0.03	0.01		0.1
8	7.09	0.02	0.01		0.1
9	7.03	0.015	0.01		0.1
10	7.02	0.012	0.01		0.05
11	7.02	0.01	0.01		0.05
12	7.00	0.005	0.01		0.02
13	7.00	0.004	0.01		0.02
14	6.99	0.003	0.01		0.02
15	6.98	0.002	0.01		0.02
16	6.98	0.002	0.01		0.02
17	6.98	0.002	0.01		0.02
18	6.97	0.002	0.01		0.01
19	6.86		0.01		
20	6.85		0.01		
21	6.84		0.01		
22	6.83		0.01		
23	6.81		0.01		
24	6.73		0.01		
25	6.68		0.01		
26	6.64		0.01		
27	6.5		0.01		
28	6.47		0.01		
29	6.43		0.01		
30	6.23		0.01		
31			0.01		
32			0.01		
33			0.01		
34			0.01		
35			0.01		
36			0.01		
37			0.01		
38			0.01		
39			0.01		
40			0.01		
41			0.01		
42			0.01		
43			0.01		
44			0.01		
45			0.01		
46			0.01		

Appendix B (Continued) NAVY-WIDE BILGE-WATER CHARACTERIZATION STUDY CONTAMINANT VALUES

Number of	Contaminant Values (ppm)				
Samples	Tin	TOC	TPH	TSS	Zinc
1	2	19040	14475	2684	16.2
2	2	4620	5224	1521	12
3		1050	3018	1440	6.56
4		644	2595	1205	5.2
5		570	2593	846	5
6		442	1656	670	4.81
7		264	1377	669	4.7
8		247	765	548	4.3
9		160	725	525	4.2
10		145	628	430	3.93
11		61.8	624	316	3.9
12		56.8	256	233	3.7
13		48	164	226	3.7
14		44	143	220	3.4
15		42	121	169	3.3
16		39.4	104	147	3.1
17		25.6	56	144	3
18			49.35	123	3
19			47	90	2.72
20			46	73	2.54
21			42	72	2.4
22			40	67	2.3
23			38.2	66	2.05
24			37	62	2
25			19	62	2
26			18	43	1.7
27			17	43	1.5
28			11	41	1.39
29			10	40	1.3
30			9	34	1.3
31			8	32	1.3
32			7.7	24	1.25
33			7.5	22	1.11
34			5.9	20	1
35			3.6	19	0.9
36			3.6	19	0.88
37			0.4	16	0.8
38				16	0.67
39				15	0.5
40				13	0.39
41				9	0.38
42				8.7	0.33
43				7.7	0.22
44				3.3	0.13
45					0.08
46					0.032

Appendix C INFLUENT AND EFFLUENT VALUES FROM THE NUNES STUDY

Contaminant	Influent (I) and Effluent (E) Values (ppm)									
	Sample Numbers									
	I108 I110	E112 E114	I155 I156	E161	I145 I146	E150	I135 I136	E139	I123 I126	E128 E129
Silver	<0.012		<0.012		<0.012		<0.012		<0.012	
Arsenic	<0.27		<0.27		<0.27		<0.27		<0.27	
Barium	0.08		0.089		0.113	0.025	0.084		0.07	
Beryllium	<0.008		<0.008		<0.008		<0.008		<0.008	
Cadmium	0.04		0.055		0.05		0.057		0.062	
Chromium	0.059		0.032		0.041		0.047		0.062	
Copper	0.087		0.035		0.04		0.038		0.095	
Mercury	<0.05		<0.05		<0.05		<0.05		<0.05	
Manganese	0.184	0.056	0.153	0.01	0.165	0.008	0.173	0.031	0.153	0.32
Nickel	0.13		0.21	0.1	0.27	0.1	0.28	0.12	0.17	
Lead	<0.35		<0.35		<.035		<0.35		<0.35	
Selenium	<0.30		<0.30		<0.30		<0.30		<0.30	
Thallium	<0.33		<0.33		<0.33		<0.33		<0.33	
Tin	1.2		1.2		1.4		2	0.95	1.3	
zinc	0.184	0.045	0.08		0.11	0.005	0.107	0.075	0.207	0.105
pH	7.61	8.39	7.04	8.38	7.48	8.14	7.66	8.17	7.06	7.62
Cyanide	<0.25		<0.25		<.025		<0.25		<0.25	
Sulfide	71		100		137		188		171	
TSS	21	105	<10	54	33	29	15	46	26	49
TOC	136	95	35	123	30	112	68	83	258	223
MBAS	3	3	<0.1		0.2	1.2	0.15	1.1	0.25	0.85
O&G	11	7.5	3.5	5.2	5.2	2.9	4.1	2.9	5.2	1.9
TPH	8.6	5.4	1.9	3.1	3.5	1.6	2.9	1.9	4.8	1.2
COD	430	180	880	340	930	450	910	400	790	550
Chloride	8300	8600	12300	10000	11600	9900	12600	10000	10400	9550

Appendix C (Continued) INFLUENT AND EFFLUENT VALUES FROM THE NUNES STUDY

Contaminant	Influent (I) and Effluent (E) Values (ppm)									
	Sample Numbers									
	I090 I092	E094 E095	I086 I087	E079 E081	I071 I072	E074 E075	I061 I062	E064 E065	I042 I043	E044 E045
Silver	<0.012		<0.012		<0.012		<0.012		<0.012	
Arsenic	<0.27		<0.27		<0.27		<0.27		<0.27	
Barium	0.056		0.054		0.054		0.039		0.061	
Beryllium	<0.008		<0.008		<0.008		<0.008		<0.008	
Cadmium	0.052		0.051		0.062		<0.032		0.041	
Chromium	0.046		0.042		0.065		0.039		0.049	
Copper	0.091		0.081		0.155	0.02	0.232	0.008	0.193	0.014
Mercury	<0.05		<0.05		<0.05		<0.05		<0.05	
Manganese	0.105	0.011	0.102	0.021	0.103	0.017	0.083		0.117	0.014
Nickel	0.22	0.1	0.26	0.11	0.28	0.1	0.21	0.09	0.26	0.1
Lead	<0.35		<0.35		<0.35		<0.35		<0.35	
Selenium	<0.30		<0.30		<0.30		<0.30		<0.30	
Thallium	<0.33		<0.33		<0.33		<0.33		<0.33	
Tin	2	0.83	2.3	0.92	1.5		1.1		1.1	
zinc	0.184	0.021	0.195	0.089	0.205	0.067	0.371	0.033	0.485	0.037
pH	7.88	8.74	7.8	8.64	7.66	8.61	6.93	9.17	7.15	8.88
Cyanide	<0.25		<0.25		<0.25		<0.25		<0.25	
Sulfide	64		68		55		14		27	
TSS	13	62	20	24	20	39	23	17	23	33
TOC	122	51	125	49	107	54	67	60	163	127
MBAS	0.3	0.6	0.4	0.7	0.35	0.6	0.15	0.4	0.15	1.3
O&G	22	2.8	18	4.3	26	7.1	35	5.2	69	17
TPH	22	1.5	20	3.9	25	5.9	38	4.8	74	22
COD	230	270	290	180	330	180	230	240	520	430
Chloride	9400	8750	9450	9300	9500	9150	7100	7100	8050	7800

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